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KANAWHA RIVER INVESTIGATION OF WATER QUALITY AND WATER POLLUTION CONTROL PRACTICES

VOLUME II. REPORTS OF INDUSTRIAL INVESTIGATIONS ON SEVEN INDUSTRIES

ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, D.C.

JULY 1973

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The Kanawha River is located entirely within the state of West Virginia. This report describes the result of an investigation by the United States Environmental Protection Agency (EPA) that set out to ascertain the adequacy of wastewater treatment given to discharges located on the Kanawha River and to determine additional waste reductions necessary to attain water quality standards. Forty industries have been investigated individually to evaluate pollution control efforts, and to determine what further actions are needed in each instance.

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KANAWHA RIVER
INVESTIGATION OF WATER QUALITY AND WATER POLLUTION CONTROL PRACTICES

VOLUME II

REPORTS OF INDUSTRIAL INVESTIGATIONS ON SEVEN INDUSTRIES

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT AND GENERAL COUNSEL

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U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

KANAWHA RIVER

INVESTIGATION OF WATER QUALITY

AND

WATER POLLUTION CONTROL PRACTICES

VOLUME II

REPORTS OF INDUSTRIAL INVESTIGATIONS

ON SEVEN INDUSTRIES

A. E. I. du Pont de Nemours and Company, Belle

B. Union Carbide Corporation, South Charleston

C. Union Carbide Corporation, Institute

D. FMC Corporation, Inorganic Chemicals Division, South Charleston

E. FMC Corporation, American Viscose Division, Nitro

F. FMC Corporation, Organic Chemicals Division, Nitro

G. Monsanto Company, Nitro

United States Environmental Protection Agency

Office of Enforcement and General Counsel

National Field Investigations Center - Cincinnati

and

Region III - Philadelphia

July, 1973

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INTRODUCTION

The Kanawha River is located entirely within the State of West Virginia. The New River tributary to the Kanawha River with its headwaters in North Carolina and flow in southwestern Virginia has caused the Kanawha to be designated as an interstate stream. The quality of the river changes dramatically between its origin and its mouth, as described in Volume 1 of this report. Most of this change is man-related and, in turn, is derived principally from industrial waste discharges to the river. By comparison, pollution from domestic wastes and surface water runoff contributions are small, although they, too, will affect the quality of the river if industrial discharges are minimized.

The area of this investigation has been limited to the Kanawha River main stem from its origin at the confluence of the New and Gauley rivers to the juncture of the Kanawha and Ohio Rivers, a total length of 97 miles. The Ohio River, a few miles upstream and downstream from the mouth of the Kanawha, has also been included to determine the effects of the Kanawha River on the Ohio. The locations of Kanawha municipalities and the larger industries are indicated in Figure 1.

This report describes the result of an investigation by the United States Environmental Protection Agency (EPA) that set out → p 3

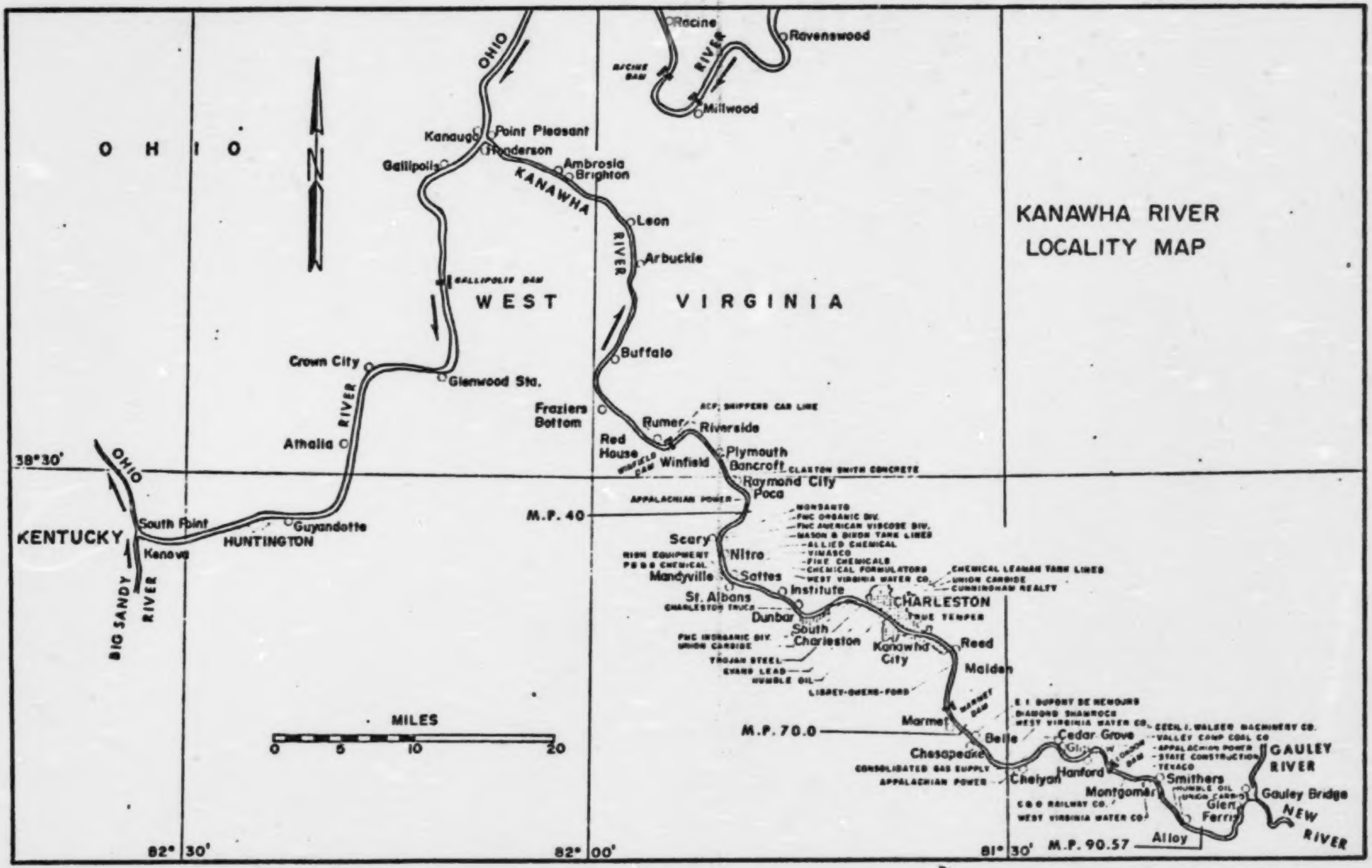
KANAWHA RIVER
LOCALITY MAP
OHIO
WEST VIRGINIA
KENTUCKY
N
OHIO
OHIO RIVER
KANAWHA RIVER
RIVER
BIG SANDY RIVER
GAULEY RIVER
NEW RIVER
Racine
Ravenswood
RACINE DAM
Millwood
Kanauga
Point Pleasant
Henderson
Gallipolis
Ambrosia
Brighton
Leon
Arbuckle
GALLIPOLIS DAM
Crown City
Glenwood Sta.
Athalia
Guyandotte
HUNTINGTON
South Point
Kenova
Buffalo
Fraziers Bottom
Red House
WINFIELD DAM
Winfield
Rumer
Riverside
ACF; SHIPPERS CAR LINE
Plymouth
Bancroft
CLAXTON SMITH CONCRETE
Raymond City
Poca
APPALACHIAN POWER
M.P. 40
MONSANTO
FMC ORGANIC DIV.
FMC AMERICAN VISCOSE DIV.
MASON & DIXON TANK LINES
ALLIED CHEMICAL
VIMASCO
FINE CHEMICALS
CHEMICAL FORMULATORS
WEST VIRGINIA WATER CO.
Scary
RISH EQUIPMENT
P B & D CHEMICAL
Nitro
Mandyville
Sattes
Institute
St. Albans
CHARLESTON TRUCK
Dunbar
South Charleston
FMC INORGANIC DIV.
UNION CARBIDE
TROJAN STEEL
EVANS LEAD
HUMBLE OIL
LIBBEY-OWENS-FORD
CHEMICAL LEAMAN TANK LINES
UNION CARBIDE
CUNNINGHAM REALTY
CHARLESTON
TRUE TEMPER
Kanawha City
Reed
Malden
MARMET DAM
Marmet
M.P. 70.0
E I DUPONT DE NEMOURS
DIAMOND SHAMROCK
WEST VIRGINIA WATER CO.
Belle
Chesapeake
CONSOLIDATED GAS SUPPLY
APPALACHIAN POWER
Chelyan
Cedar Grove
Glasgow
LONDON DAM
Hanford
CECIL I. WALKER MACHINERY CO.
VALLEY CAMP COAL CO
APPALACHIAN POWER
STATE CONSTRUCTION
TEXACO
Smithers
HUMBLE OIL
UNION CARBIDE
Montgomery
C & O RAILWAY CO.
WEST VIRGINIA WATER CO.
Glen Ferris
Gauley Bridge
Alloy
M.P. 90.57
MILES
0
5
10
20
38°30'
82° 30'
82° 00'
81° 30'

FIGURE 1

Cont'd from p 1

to ascertain the adequacy of wastewater treatment given to discharges located on the Kanawha River and to determine additional waste reductions necessary to attain water quality standards. Forty industries have been investigated individually to evaluate pollution control efforts, and to determine what further actions are needed in each instance.

The Kanawha River Industrial Advisory Committee (KRIAC) was initially contacted. KRIAC, a State-Industry committee, was established in 1958 to guide the industrial pollution control efforts. A letter from the EPA NFIC-Cincinnati Director was sent to the managements of forty industries discharging directly to the Kanawha River requesting cooperation and information concerning pollution abatement activities. EPA personnel visited the forty industries between January and March, 1972. The approach varied depending upon the size, complexity, and pollutional impact of the industry. Industry personnel were advised that the information gathered could result in a federal enforcement action. A split wastewater sampling procedure was initiated during each plant visit to provide a check of federal, state, and company data. A draft report was provided to each plant manager who in turn was requested to furnish EPA with written comments.

The State of West Virginia is represented on the committee by the Department of Natural Resources, Division of Water Resources, which is the state water pollution regulatory agency. That agency participated in the investigations to the fullest extent possible.

The recommendations made in each of the reports as to effluent limitations are based solely on information available to the authors and must be considered as minimum. In each case the recommendations are not to be construed to supersede any federal, state, or local government requirements may be more stringent.

The seven KRIAC industries described in this volume are:

A. E. I. du Pont de Nemours and Company, Belle

B. Union Carbide Corporation, South Charleston

C. Union Carbide Corporation, Institute

D. FMC Corporation, Inorganic Chemicals Division, South Charleston

E. FMC Corporation, American Viscose Division, Nitro

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A

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WATER POLLUTION CONTROL PRACTICES

VOLUME II
REPORTS OF INDUSTRIAL INVESTIGATIONS
ON SEVEN INDUSTRIES

A. E. I. duPont de Nemours and Company, Incorporated
Biochemicals Department
Belle Plant
Belle, West Virginia

United States Environmental Protection Agency
Office of Enforcement and General Counsel
National Field Investigations Center - Cincinnati
and
Region III - Philadelphia
July, 1973

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REPORT OF INDUSTRIAL INVESTIGATION

E. I. DU PONT DE NEMOURS AND COMPANY, INCORPORATED

BELLE PLANT

BELLE, WEST VIRGINIA

GENERAL PLANT DESCRIPTION

The Belle Plant of the DuPont Company is located on the Kanawha River about ten miles above Charleston, West Virginia, at river mile point 68.5. It lies entirely on the right side of the river (facing downstream) and occupies just under one mile of the river shoreline. The plant area is approximately 104 acres. Figure 1 shows the general plant layout.

The Belle Plant started operation in 1926 with one product - ammonia. By 1933, employment had risen to 600 and in the late 1940's approximately 5,000 persons were employed. In 1945, the Belle Plant was one of the two largest in the DuPont Company.

At present the plant employs approximately 1,700 persons and manufactures more than thirty chemical products, the major ones being ammonia, urea, nylon intermediates, ethylene glycol, methylamines, formaldehyde, and methacrylates. The plant

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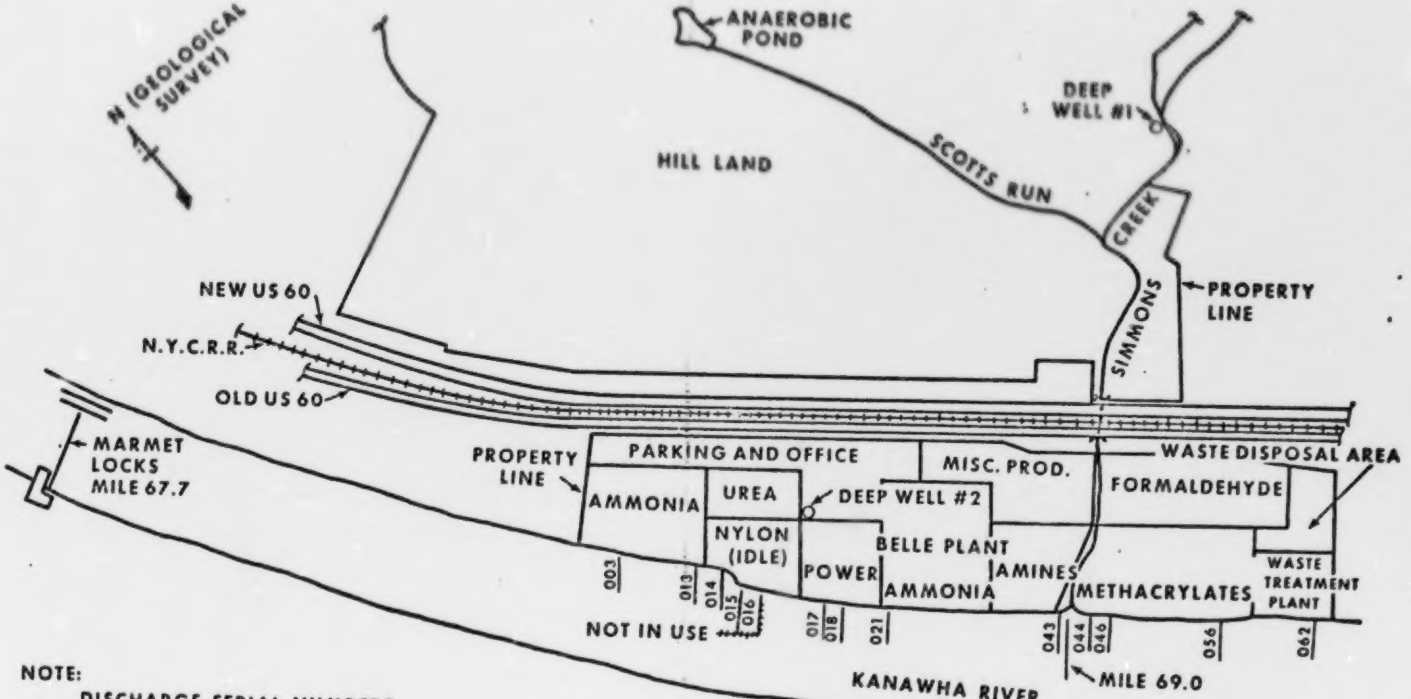
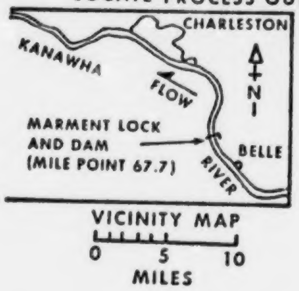

ANAEROBIC POND
HILL LAND
N (GEOLOGICAL SURVEY)
DEEP WELL #1
SCOTTS RUN
CREEK
SIMMONS
PROPERTY LINE
NEW US 60
N.Y.C.R.R.
OLD US 60
MARMET LOCKS MILE 67.7
PROPERTY LINE
PARKING AND OFFICE
MISC. PROD.
WASTE DISPOSAL AREA
AMMONIA
UREA
DEEP WELL #2
FORMALDEHYDE
NYLON (IDLE)
BELLE PLANT
POWER
AMMONIA
AMINES
METHACRYLATES
WASTE TREATMENT PLANT
003
013
014
015
016
NOT IN USE
017
018
021
043
044
046
056
062
MILE 69.0
KANAWHA RIVER

NOTE:
DISCHARGE SERIAL NUMBERS
LOCATE PROCESS OUTFALLS.


CHARLESTON
KANAWHA
FLOW
N
MARMENT LOCK AND DAM (MILE POINT 67.7)
BELLE
RIVER
0
5
10
MILES

VICINITY MAP

FIGURE 1
GENERAL PHYSICAL LAYOUT
AND BELLE PLANT OUTFALL LOCATIONS

E. I. DUPONT DENEMOURS & CO.
BELLE PLANT
BELLE, KANAWHA COUNTY, W. VA.
DECEMBER 4, 1972

0 5,000 10,000
FEET

operates continuously with minor seasonal variations in production. The amount of production was not ascertained.

The principal raw materials used at the DuPont Belle Plant are natural gas, coal, air, and water.

WATER USAGE

The plant withdraws its water supply (175 mgd) from the Kanawha River. It provides water for three systems: raw water, filtered water (soft and potable), and fire protection. The plant water balance is shown in Table 1. Ninety-eight percent of the water used is returned to the river untreated, mainly as "non-contact" cooling water. The wastewater treatment plant handles 2.41 mgd, returning the water to the Kanawha River. Water usage has declined steadily from 95.4 billion gallons in 1967 to 61.1 billion gallons in 1971.

WASTEWATER DISCHARGES AND WASTE SOURCES

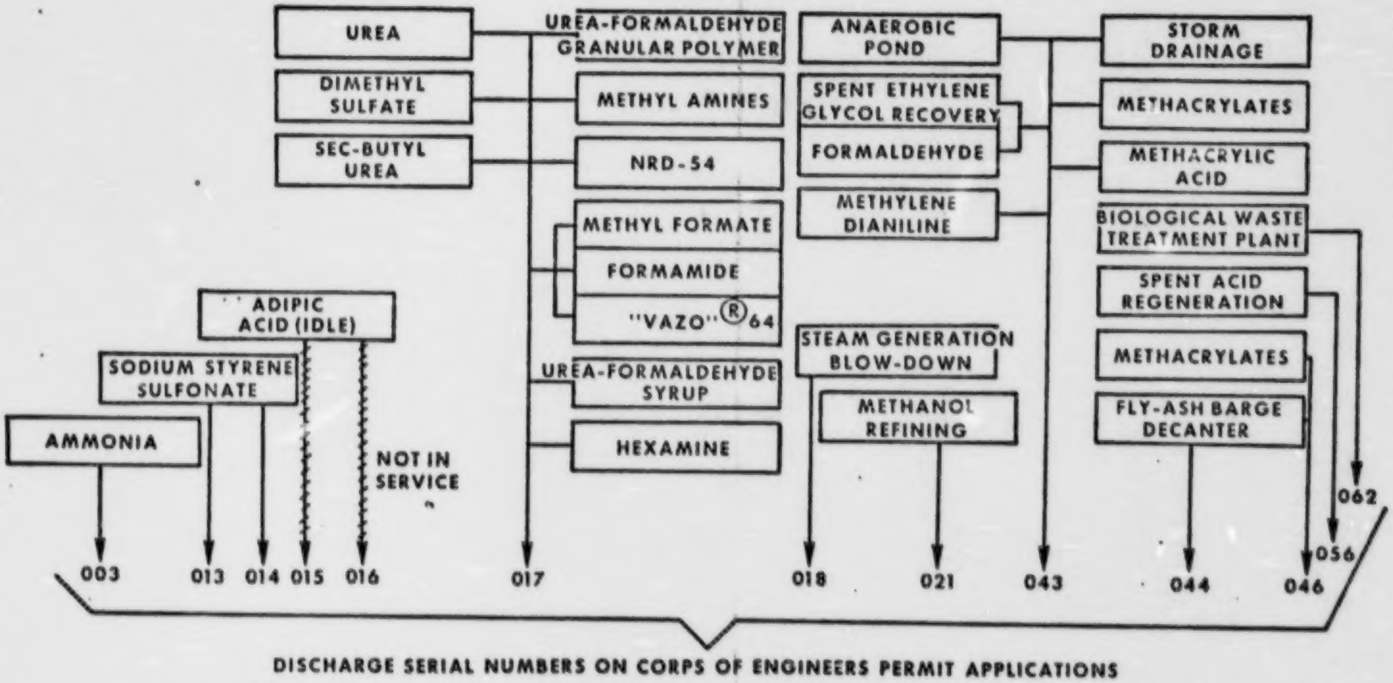
The Du Pont plant has 62 outfalls to the Kanawha River. According to plant information, 49 are for cooling water, condensate, pump backflushes, and surface run-off; ten contain some process wastes in cooling water; one is from the wastewater treatment plant and two are inactive. The eleven outfalls (including the wastewater treatment plant) which contain process wastes are shown on the schematic diagram in Figure 2, along with the sources

Table 1

WATER USE AND DISPOSAL METHOD

E. I. duPont de Nemours and Company
Belle, West Virginia

Inlet Water Uses	Water Use (MGD)	Disposal Method River (MGD)	Disposal Method Treat (MGD)	Disposal Method Well (MGD)	Disposal Method Barge (MGD)	Process Mfgr. (MGD)
Non-Contact Cooling	167	167				
Contact Cooling	.55		.55			
Boiler Feed	3.0	2.2				.8
Process	1.64		.55	.22	.03	.84
Fume Scrubbing	.22		.22			
Cleanup	.055		.055			
Fly Ash Sluicing	.055	.055				
Pump Backwash	1.92	1.92				
Sanitary	1.04		1.04			
TOTALS	175.3	171.0	2.41	.22	.03	1.64


UREA
DIMETHYL SULFATE
SEC-BUTYL UREA
ADIPIC ACID (IDLE)
SODIUM STYRENE SULFONATE
AMMONIA
NOT IN SERVICE
UREA-FORMALDEHYDE GRANULAR POLYMER
METHYL AMINES
NRD-54
METHYL FORMATE
FORMAMIDE
"VAZO"® 64
UREA-FORMALDEHYDE SYRUP
HEXAMINE
ANAEROBIC POND
SPENT ETHYLENE GLYCOL RECOVERY
FORMALDEHYDE
METHYLENE DIANILINE
STEAM GENERATION BLOW-DOWN
METHANOL REFINING
STORM DRAINAGE
METHACRYLATES
METHACRYLIC ACID
BIOLOGICAL WASTE TREATMENT PLANT
SPENT ACID REGENERATION
METHACRYLATES
FLY-ASH BARGE DECANTER
003
013
014
015
016
017
018
021
043
044
046
056
062
DISCHARGE SERIAL NUMBERS ON CORPS OF ENGINEERS PERMIT APPLICATIONS

← KANAWHA RIVER

MAJOR OUTFALL FLOWS	
003	47.95 mgd
013	1.30 mgd
014	1.29 mgd
017	58.75 mgd
018	0.01 mgd
021	2.05 mgd
043	21.02 mgd
044	0.05 mgd
046	1.08 mgd
056	9.94 mgd
062	2.39 mgd
TOTAL	144.83 mgd

E.I. DUPONT DENEMOURS & CO.
BELLE PLANT
BELLE, KANAWHA COUNTY, W. VA.

FIGURE 2
MAJOR DISCHARGE OUTFALLS TO KANAWHA RIVER

of wastes and the average flow from each. Figure 3 shows, again by schematic diagram, the process sources of wastes discharged to the wastewater treatment plant. These diagrams should be compared to the general plant layout in Figure 1 which indicates area locations of outfalls. These eleven outfalls discharge approximately 145 mgd. Although the principal function of all these discharges, except that of the wastewater treatment plant, is the disposal of cooling waters, each contains varying amounts of process wastes. Outfall Nc. 043 is Simmons Creek, which runs through the plant area.

WASTE TREATMENT PROGRAM

Historical Development

The DuPont Plant at Belle began a waste reduction program in 1945. Between 1945 and 1972 the summertime BOD_5 load to the river was reduced from 350,000 pounds per day to less than 21,000 pounds per day. The wintertime load is currently about 40,000 pounds per day. Wintertime loads throughout this period have always been higher than summer loads.

The waste reduction program at the Du Pont Plant can be divided into three periods, 1945-1958, 1959-1964 (State Phase I Program), and 1965-1972 (State Phase II Program). The plant is just beginning its Phase III Program.

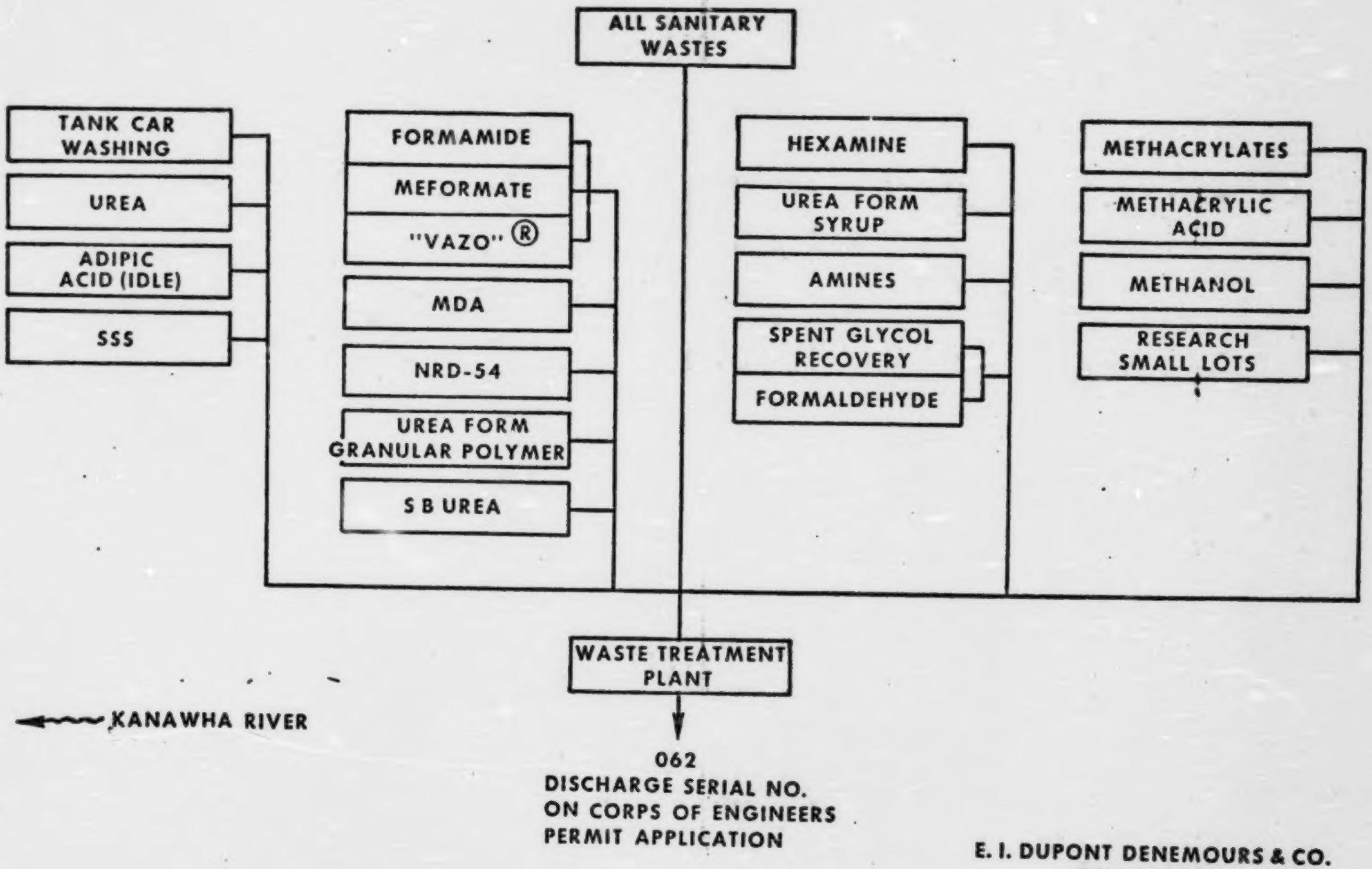

ALL SANITARY WASTES
TANK CAR WASHING
UREA
ADIPIC ACID (IDLE)
SSS
FORMAMIDE
MEFORMATE
"VAZO" ®
MDA
NRD-54
UREA FORM GRANULAR POLYMER
S B UREA
HEXAMINE
UREA FORM SYRUP
AMINES
SPENT GLYCOL RECOVERY
FORMALDEHYDE
METHACRYLATES
METHACRYLIC ACID
METHANOL
RESEARCH SMALL LOTS
WASTE TREATMENT PLANT
KANAWHA RIVER
062
DISCHARGE SERIAL NO.
ON CORPS OF ENGINEERS
PERMIT APPLICATION

FIGURE 3
PROCESS AND SANITARY
WASTE COLLECTION SYSTEM

E. I. DUPONT DENEMOURS & CO.
BELLE PLANT
BELLE, KANAWHA COUNTY, W. VA.
FEBRUARY 25, 1972

During the first period, 1945 to 1958, the DuPont plant had no waste treatment plant and its efforts were directed primarily to process changes and controls. Waste reduction included twelve pollution control measures.

1. Installation of calandrias on open-bottom stream stills.
2. Refrigerated condensers ahead of some vacuum jets.
3. Redesign of intermediate process steps.
4. Ammonium sulfate recovery plant and incineration of waste oil.
5. Catalytic oxidation of condensed organic vapors.
6. Flyash collection and sluicing to pond.
7. Barging of fly ash and conversion of fly ash pond to anaerobic digestion facility for organic wastes.
8. Liquid waste incineration.
9. Installation of continuous automatic samplers.
10. Impounding of wastes during summer for release to the river during winter high flows.
11. Conversion from coal to natural gas for process gases.
12. Thermal decomposition unit for volatile materials.

DuPont reports that by 1958 the summer BOD_5 load to the river had been reduced to 50,000 pounds per day.

The second period, 1959 to 1964, of the plant's waste control effort was dominated by the installation of collection and treatment pollution control program on the Kanawha River. Under those conditions DuPont was to reduce its monthly average BOD_5 load to the river during low flow periods to not more than 35,000 pounds per day.

The first unit was an aerobic waste treatment plant placed in operation in 1961. With this plant and increased process control DuPont's summer BOD_5 was reduced to 35,000 pounds per day.

The third period, 1964 to 1972, of waste control effort at DuPont began with the issuance in October, 1964, of the State Phase II permit in which the company was to reduce its summer loads of BOD_5 to not more than 21,000 pounds per day and oxidizable nitrogen to not more than 28,000 pounds per day. Impounding of wastes for winter release to the river was to be discontinued.

The conditions of the Phase II were met, according to DuPont, by the following actions:

1. Expansion of the aerobic wastewater treatment plant.
2. New ammonia production plant.
3. Replacement of ammonium sulfate plant with spent acid regeneration consisting of a recovery and recycle system.
4. Facilities to burn liquid wastes under powerhouse boilers.
5. Barging of salt brines to Gulf of Mexico.

6. Elimination of impounding (1970) by use of deep wells, process changes, and shutdown of production facilities.
7. Phaseout of nylon intermediate production and shutdown of thermal decomposition unit.
8. Retirement of catalytic oxidation unit with shutdown of production facilities.
9. Incorporation of waste control in design of new or modernized units.

Table 2 shows the 1971 monthly total plant loadings to the Kanawha River, as reported by the company to the State, of BOD_5, COD, ammonia nitrogen, and total Kjeldahl nitrogen. These loading data indicate that the plant was meeting its Phase II permit conditions for river loadings.

The Belle Plant generates a relatively constant waste load, but the five-day biochemical oxygen demand and the total oxidizable nitrogen discharged may vary by a factor of two from summer to winter conditions. The increase during winter is attributed to several factors:

1. The anaerobic and aerobic biological treatment facilities operate at reduced efficiencies due to lower temperature.
2. Maintenance of waste treatment equipment, hydrostatic testing of pressure vessels, and cleaning of equipment

Table 2

TOTAL COMBINED

DU PONT BELLE PLANT EFFLUENT LOADINGS - 1971

MONTH	MONTHLY AVERAGE DISCHARGE - NET POUNDS/DAY			
	BOD_5	COD	NH_3-N	TOTAL KJELDAHL-N
JANUARY	27,198	90,328	23,040	32,000
FEBRUARY	20,948	90,370	21,794	33,076
MARCH	29,490	74,124	19,200	34,560
APRIL	40,098	66,226	21,528	27,261
MAY	30,822	52,036	15,736	23,223
JUNE	20,397	45,341	15,240	15,621
JULY	17,275	66,517	14,124	22,855
AUGUST	11,713	61,133	9,114	13,020
SEPTEMBER	19,902	37,236	11,640	21,049
OCTOBER	13,374	40,776	7,153	13,441
NOVEMBER	17,499	58,440	11,700	14,625
DECEMBER	20,439	49,762	9,750	14,625
ANNUAL AVERAGE FOR 1971	22,430	61,024	15,002	22,113

is performed during the winter months to lessen the impact on the river.

3. At times the liquid level in the anaerobic pond must be pumped down to reduce the liquid level from ground water entering the pond.

The fourth period of DuPont's waste control program will incorporate the requirements of the State Phase III Program. The State advised the company in December, 1969, of the general requirements, a part of which called for "85 percent and 65 percent reduction of the first and second stage BOD_{20}, respectively," presumably of loads existing at that time. It was not until May, 1972, that the State advised DuPont of permissible waste loads, BOD_5 not to exceed 15,000 pounds per day and oxidizable nitrogen not to exceed 18,000 pounds per day as monthly averages. An adjustment is being negotiated to compensate for lower efficiencies during cold weather. A compliance program and schedule is to be submitted to the State after all requirements are specified. The company expects that expansion of the aerobic waste treatment plant will be required to achieve compliance.

The State goal for completion of Phase III is December 31, 1972. This date does not appear realistic in the case of DuPont, where new construction is required.

Existing Waste Treatment Facilities

The waste control practices in use today at the DuPont Plant are:

1. Aerobic wastewater treatment plant.
2. Anaerobic pond.
3. Incineration.
4. Powerhouse burning.
5. Fly ash barging to local landfill.
6. Salt brine barging to Gulf of Mexico.
7. Deep-well disposal.
8. Process modifications and operational controls.
9. Daily monitoring.

Deep Well Disposal and Barging to Sea

Two deep disposal wells are being operated under state permit. The first deep well permit was issued in 1966 and covers a well drilled to a depth of 1,500 feet. The second permit was obtained in 1967 for a well drilled to 5,400 feet, most of the liquid flows just above the 4,300-foot depth with the remainder at lower depths. Organics and brines incompatible with other treatment systems are discharged to the wells. Table 1 shows 220,000 gallons per day to deep well disposal and the company indicates a BOD_5 disposal of 12,000 pounds per day by this method.

Approximately 30,000 gallons per day of salt brine is barged to the Gulf of Mexico for discharge into a minimum water depth of 100 fathoms about 100 miles from the Gulf Coast.

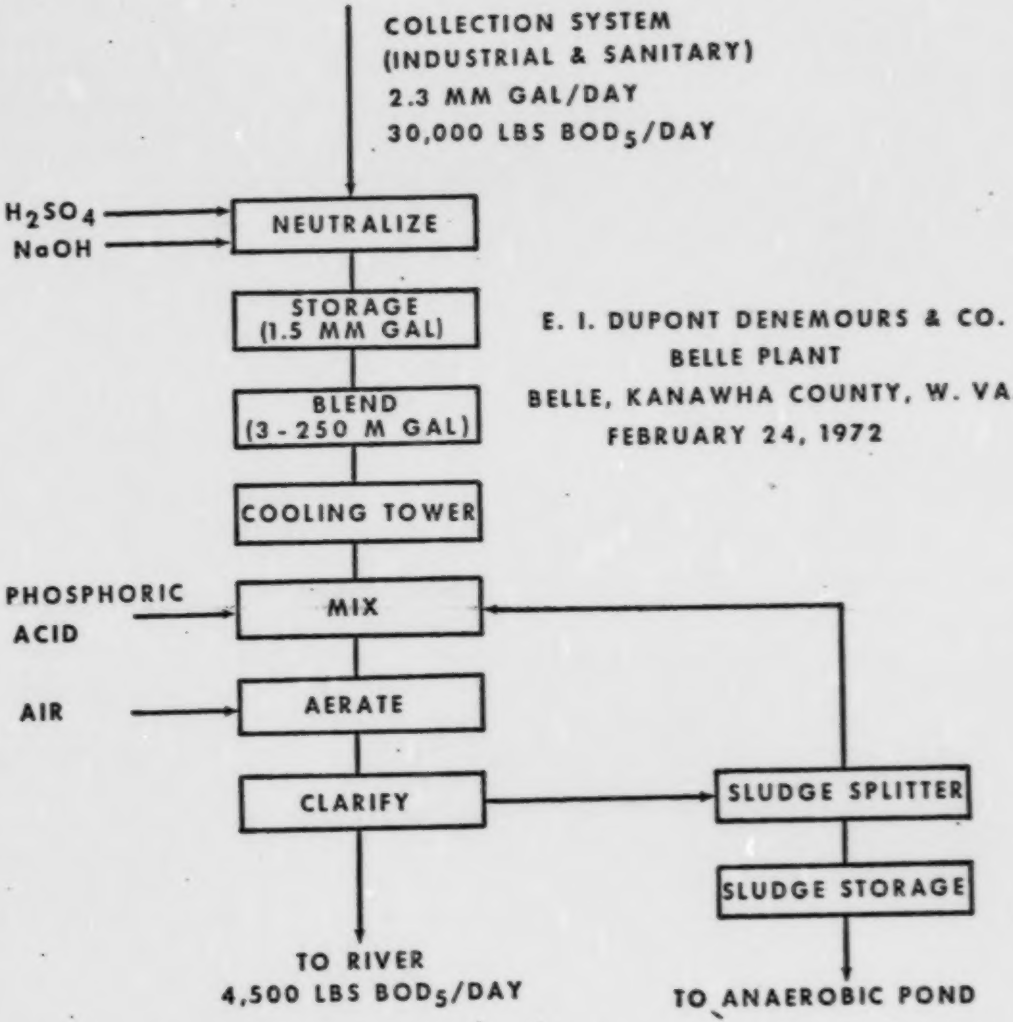
Wastewater Disposal

WWTP Description and Cooling Water

Figure 4 is a block flow diagram of the Belle Plant activated sludge waste treatment plant. This is an aerobic digestion system with an efficiency of approximately 85 percent in summer and 75 percent in winter. The waste sludge is pumped to the anaerobic pond and destroyed by digestion. The design capacity of the plant is 30,000 pounds per day BOD_5 but during peak loads it handles up to 40,000 pounds per day BOD_5.

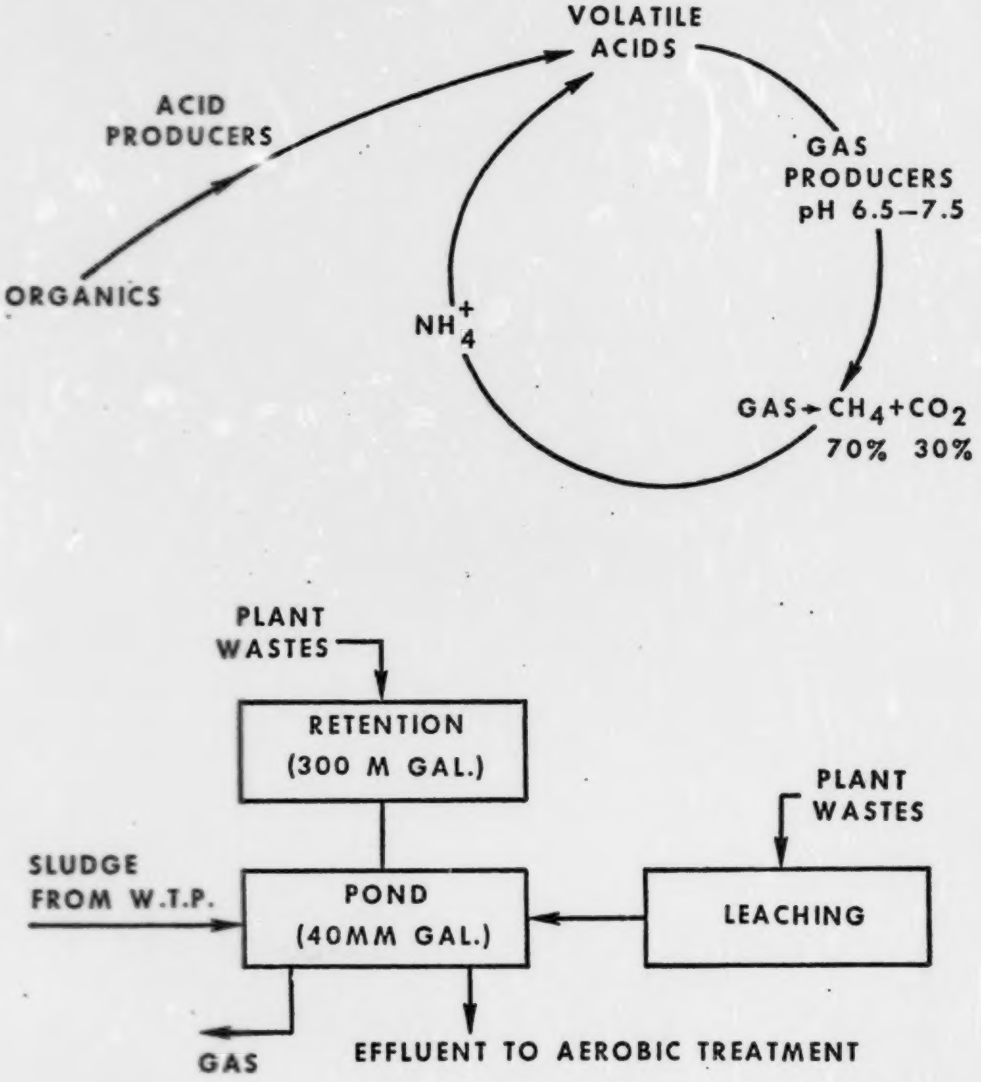
Figure 5 is a block flow diagram of the seven acre anaerobic digestion pond and its principle of operation. A 300,000 gallon reservoir is used to store and blend the wastes and adjust the pH. The desired quantities of phosphates and ammonia are added as nutrients and the wastes are fed to the pond at a controlled, continuous rate.

The anaerobic pond receives organic wastes amenable to anaerobic digestion. In addition, all of the waste activated sludge (6,000 pounds per day dry weight) from the aerobic treatment plant is fed to the pond. The organics deposited in the pond are acted on by acid producing micro-organisms. Volatile acids are formed and gas producing micro-organisms liberate methane


COLLECTION SYSTEM
(INDUSTRIAL & SANITARY)
2.3 MM GAL/DAY
30,000 LBS BOD_5/DAY
H_2SO_4
NaOH
NEUTRALIZE
STORAGE (1.5 MM GAL)
BLEND (3 - 250 M GAL)
COOLING TOWER
PHOSPHORIC ACID
MIX
AIR
AERATE
CLARIFY
SLUDGE SPLITTER
SLUDGE STORAGE
TO RIVER
4,500 LBS BOD_5/DAY
TO ANAEROBIC POND

E. I. DUPONT DENEMOURS & CO.
BELLE PLANT
BELLE, KANAWHA COUNTY, W. VA.
FEBRUARY 24, 1972

FIGURE 4
ACTIVATED SLUDGE
WASTE TREATMENT PLANT


VOLATILE ACIDS
ACID PRODUCERS
ORGANICS
GAS PRODUCERS pH 6.5–7.5
NH_4^+
GAS → CH_4 + CO_2
70% 30%
PLANT WASTES
RETENTION (300 M GAL.)
SLUDGE FROM W.T.P.
POND (40MM GAL.)
PLANT WASTES
LEACHING
GAS
EFFLUENT TO AEROBIC TREATMENT

E. I. DUPONT DENEMOURS & CO.
BELLE PLANT
BELLE, KANAWHA COUNTY, W. VA.
FEBRUARY 24, 1972

FIGURE 5
ANAEROBIC POND

and CO_2 which bubble to the top and are discharged to the atmosphere. Ammonia from this action is recycled to the volatile acids. The BOD_5 removal efficiency of this facility is approximately 80 percent in summer and 40 percent in winter. The effluent from the anaerobic pond was to be routed to the aerobic treatment plant in 1972.

Cooling Water

Non-contact cooling water which comprizes 167 million gallongs per day is directly discharged to the Kanawha River. The contact cooling water volume is 550,000 gallons per day, which is disposed of to the aerobic treatment plant for further treatment.

Monitoring

Analyses conducted by the DuPont Belle Plant are indicated in Figure 6. An asterisk indicates characteristics reported to the state on a monthly or annual basis. Abnormal discharges are also reported if any occurred during the month. There were no abnormal discharges during the period from September 15 through October 20, 1971, while the river sampling program was underway. However, the Belle Ammonia Plant was shut down from September 6 until October 12, 1971, and the Urea Plant operated at approximately 25 percent of capacity from September 13 until September 30, 1971.

RIVER OUTFALLS	COD(AUTO)•	COD(TITRATION)	BOD$_5$	NH3-N(AUTO)	TOT. KJEL. N$_2$	NH3-N	ORGANIC-N$_2$	NO$_3$	NO$_2$	pH	SUSP. SOLIDS	TOT. SOLIDS	TOT. CARBON	ODOR	CHLORIDE	UREA	CYANIDE	HARDNESS	ACIDITY	COPPER	ALKALINITY	SULFATE
003	D	W	W	D						C			W									
013	D	W	W							C			W C									
014	D	W	W										W C									
017	D	W	W	D									W		D							
021	D	W	W	D									W									
043	D	W	W	D						C			W C									
046	C	W	W	D									W									
056										W									W	W		
062	D	W	W	D	W					W			W									
EFFLUENT COMPOSITE		W	W•		W M•	M•	M•	M•	M•	W M•	M•	M•	W	W M	A•		A•	A•			A•	A•
INFLUENT RAW H$_2$O COMPOSITE	D	W	W•	D	W M•	M•	M•	M•	M•	W M• C	M•	M•	W	W M	A•		A•	A•			A•	A•
IN-PLANT BRANCH SEWERS																						
7 LOCATIONS	D			D																		
5 LOCATIONS	C									C			C									
3 LOCATIONS	D			D											D							
5 RAW WATER LOCATIONS	D			D																		

ANALYSIS FREQUENCY
C - CONTINUOUSLY
D - DAILY
W - WEEKLY (COMPOSITE)
M - MONTHLY (COMPOSITE)
A - ANNUALLY
• REPORTED TO STATE

FIGURE 6

BELLE PLANT - POLLUTION CONTROL ANALYSES
E.I. DUPONT DENEMOURS AND COMPANY, INCORPORATED

A-19

	COD(AUTO)	BOD5	pH	ODOR	CHLORIDE	TOT. KJEL. N2	NH3-N	DISS. O2	INERT SOLIDS	SUSP. SOLIDS	TOT. CARBON	TEMPERATURE	ALKALINITY	AMM. SALTS	VOL. ACIDS	PO4	UREA	SETTLEABILITY
WASTE TREATMENT																		
• INFLUENT	C	W	C				D				W	C					D	
• EFFLUENT	3/D	W				W	W				W							
• AERATORS			C					12/D		3/D		C						12/D
• RET. SLUDGE									W	W								
ANAEROBIC POND																		
• POND	W	W	W			W	W						W	W	W	AR		
• EFFLUENT	W	W	W			W	W						W	W	W			
• RETENTION POND	AR	AR	AR															
KANAWHA RIVER																		
• CHELYAN			2/W*	2/W*	2/W*	W*	W*	2/W*				2/W*						
• KANAWHA CITY			2/W*	2/W*	2/W*	W*	W*	2/W*				2/W*						
• BELLE PLANT			C									C						

ANALYSIS FREQUENCY

C - CONTINUOUSLY
D - DAILY
W - WEEKLY
AR - AS REQUESTED - (NOT SCHEDULED)
* - REPORTED TO STATE

FIGURE 6 (continued)
BELLE PLANT - POLLUTION CONTROL ANALYSES
E. I. DUPONT DENEMOURS AND COMPANY, INCORPORATED

Efficiency

The total raw waterborne waste loads generated in the DuPont plant have not been determined precisely, but in 1971 the raw BOD_5 load must have been at least equal to the loads introduced to the wastewater aerobic treatment plant, plus the anaerobic pond influent, plus the deep well load, plus the loads discharged via the ten cooling water effluents which contain process wastes. The total estimated raw BOD_5 loads, effluent loads, and removal efficiencies are shown in Table 3.

Table 3

Du Pont Waterborne Raw and Effluent BOD_5 Loads
and Removal Efficiency (lbs/day)
in 1971

	Raw Load	Effluent Load	Removal Efficiency
Aerobic Treatment Plant	36,500	4,000	89%
Anaerobic Pond	12,900**	7,700*	40%
Deep Well	12,000	0	-
Cooling Water	10,800	10,800***	0%
Total	72,200	22,500	69%

* Estimated effluent load from 2/72 EPA survey.

** Estimated effluent load from 2/72 EPA survey times 1.67. (40 percent winter removal)

*** 22,500 (total plant load) - 7,700 anaerobic pond load - 4,000 WWTP load)

Spill Potential

Since 1960 DuPont has had three oil spills to the river consisting of a total of 200 gallons of lubricating oil and 550 gallons of coconut oil. Three spills of refractory organics also occurred during this period from leaking barges and the quantity is unknown. Seven spills of ammonia or ammonia-urea solutions have occurred, quantity also unknown. On two occasions spills caused fish kills in the Kanawha River.

NFIC-CINCINNATI FIELD SURVEY

Sampling

In order to confirm the effluent loadings as reported by DuPont and to gather further data on other discharged constituents and the treatment plant efficiency, the EPA conducted a 24-hour sampling survey on February 23 and 24, 1972. Samples were split with DuPont and with the State Division of Water Resources.

Analysis

Comparison With Others

The analytical results, converted to pounds per day, are listed in Table 4. Most of the results were reasonably consistent between laboratories except for BOD_5, BOD_{20}, and COD. In most samples the company results were considerably higher.

Confirmation of Reported Data

The data in Table 2 and Table 4 indicate that DuPont discharges large quantities of BOD, both carbonaceous and nitrogenous, COD, organic carbon (TOC), total solids, and oil and grease.

The aerobic treatment plant was removing about 85 percent of its influent BOD_5, 80 percent of the COD, and essentially none of the nitrogen at the time of the survey.

The company appears to be meeting the State Phase II requirements for BOD and nitrogen and is close to meeting the Phase III requirements for BOD_5 (15,000 pounds per day) and oxidizable nitrogen (18,000 pounds per day) during the summer months.

Major Sources and Loads

The data in Table 4 show three significant waste outfalls; the general plant outfall (No. 017), Simmons Creek (No. 043 containing the anaerobic pond effluent), and the aerobic waste treatment plant (No. 062). The anaerobic pond effluent was to be routed to the aerobic treatment plant in 1972. If the same aerobic plant efficiency is maintained, this should result in a further reduction in average BOD_5 load of about 6,900 pounds per day, so that DuPont would nearly meet its BOD_5 Phase III permit limitation of 15,000 pounds per day for the total plant.

A large source of BOD_5, about 25 percent of the load to the river, is the "general plant outfall," Number 017. It also was discharging about 25 percent of the total solids and 75 percent of the nitrogen load during the sampling survey.

TABLE 4

EFFLUENT SAMPLING RESULTS - lbs/day

E. I. DuPont de Nemours & Co.
Belle Plant

Field Data Calculations of Net Loads

OUTFALL NUMBER	FLOW AVERAGES	BOD$_5$	BOD$_{20}$	COD	TOTAL SOLIDS	SUSPENDED SOLIDS	AMMONIA N	TOTAL K N	NO$_2$ + NO$_3$ N	T.O.C.	SULFATE	CHLORIDE	OIL & GREASE	
003	20,900 gpm			2,008	36,646	11,546	1,832	2,359	201	2,259	5,271			EPA
	20.2 MGD			9,790	40,910	13,810	1,910	2,080	133	2,920	3,360			Du Pont
	251X10^6 lbs/day													
013	916 gpm			363	7,744		7.7	17.6	8.8	99	198	110		EPA
	1.32 MGD			250	1,727		9	15	5	44	107	76		Du Pont
	11.0X10^6 lbs/day													
014	250 gpm													
	.36 MGD			84	486	156				30	117	30		EPA
	3.0X10^6 lbs/day			150	450	160				18	46	28		Du Pont
017	30,000 gpm	4,464		18,000	60,480		6,120	15,480	432	8,280	7,200	4,320	720	EPA
	43.2 MGD	7,200		36,000	68,040		5,800	13,644	389	7,200	4,460	4,000	8,680	Du Pont
	360X10^6 lbs/day													
018	10 gpm			8.3	268				1.9	2.5				EPA
	.014 MGD			16	290				2	3				Du Pont
	.12X10^6 lbs/day													
021	1,420 gpm	71		306	2,482	884	20.4	28.9	17	136			170	EPA
	2.0 MGD	153		390	2,160	950	27	27	12	68			231	Du Pont
	17.0X10^6 lbs/day													
043	19,083 gpm	7,832	19,602	11,221	84,272		595	847	573	4,580	5,954	4,580	3,664	EPA
	27.46 MGD	8,470	58,170	16,720	91,370		760	760	609	4,580	5,180	4,305	4,832	Du Pont
	229X10^6 lbs/day	6,870	10,305		84,960	48,548	779	1,214	2,477	-	-	-	-	State
044	17.4 gpm			22	345	60				5	220			EPA
	.025 MGD			2	415	105				0.4	73			Du Pont
	0.21X10^6 lbs/day													
046	750 gpm	24		99	1,260	576				63	162		108	EPA
	1.1 MGD	100		180	1,630	610				27	116		172	Du Pont
	9.0X10^6 lbs/day													
056	6,245 gpm	120		750	13,800	4,200				450	4,650	600		EPA
	8.99 MGD			750	12,075	5,175				150	2,230	585		Du Pont
	75.0X10^6 lbs/day													
062	1,582 gpm	5,092	8,816	5,757	17,252	2,432	2,470	3,800	11	2,850			38	EPA
	2.28 MGD	13,205	20,900	6,990	19,000	1,180	2,356	3,724	3	2,204			260	Du Pont
	19X10^6 lbs/day	5,263	8,341		18,658	1,748	3,249	3,743	15					State
Industrial	1,582 gpm	26,410	35,720	34,580	15,846		1,824	3,990	23	7,790			95	EPA
Raw Waste	2.28 MGD	51,300	49,400	38,000	16,530		1,690	3,610	6	8,740			540	Du Pont
	19X10^6 lbs/day													
Major Outfalls Total		17,603	28,418	38,618	225,035	19,854	11,045	22,533	1,245	18,755	23,772	9,640	4,700	EPA
Discharge		29,353	79,070	71,238	238,067	21,990	10,862	20,250	1,153	17,214	15,572	8,994	14,175	Du Pont
Less #4 Raw Water		1,461		7,792	132,464	55,518	487	974	779	6,818			0	EPA
Intake Quantities		1,948	7,792	11,688	127,594	41,882	292	292	584	2,922			12,662	Du Pont
Net Total	lbs/day	16,142		30,826	92,571	0	10,558	21,559	466	11,937			4,700	EPA Net lbs/day
Discharge		27,405	71,278	59,550	110,473	0	10,570	19,958	569	14,292			1,513	Du Pont Net lbs/day
		21,279		-	84,780	26,722	12,058	25,037	2,774	-			-	State Net lbs/day

Toxicity of Effluents

Static bioassay tests, using fathead minnows, were made on the aerobic waste treatment plant effluent in March, 1972. The tests were made in a dissolved oxygen range of 6.9 to 8.0 mg/1, pH 6.5, and temperature between 23 and 27°C. The median tolerance limit (TL_m) wastewater percentage at 24 hours was 24 percent, at 48 hours it was 24 percent, and at 96 hours it was also 24 percent. The TL_m is the percentage of a wastewater by volume which will kill 50 percent of the test organisms in the specified time.

Other effluents from Du Pont were not tested for toxicity.

Anomalies

The oil and grease analysis by Du Pont was consistently higher than the EPA values. The raw water intake analysis by DuPont indicated an extremely abnormal high value during the survey. The BOD values obtained by DuPont were also higher than those found by the EPA during the February, 1972, survey.

CONCLUSIONS

The Belle Plant generates a relatively constant waste load, but the five day biochemical oxygen demand and the total oxidizable nitrogen discharged may vary by a factor of two from summer to winter conditions. The increase during winter is attributed to the following:

1. The anaerobic and aerobic biological treatment facilities operate at reduced efficiencies due to lower temperatures.
2. Maintenance of waste treatment equipment, hydrostatic testing of pressure vessels, and cleaning of equipment is performed during the winter months to lessen the impact on the river.
3. At times the liquid level in the anaerobic pond must be pumped down to reduce the liquid level from ground water entering the pond.

The major sources of pollutants are considered to be:

1. The anaerobic pond which has a biological efficiency ranging from 40 percent to 80 percent (winter to summer).
2. The main plant outfall, 017, which contains approximately 8,000 pounds per day of ammonia-N and 5,000 pounds per day organic nitrogen (the 1971 annual average values).
3. The aerobic waste water treatment plant which had an efficiency ranging from 69.5 to 92.3 percent in 1971 (winter to summer). The efficiency observed in February was 80.7 percent BOD_5 removal.

The State of West Virginia under the Phase III Program has established a permissible waste load for the Belle Plant of

15,000 pounds per day BOD_5 on a monthly average basis, and 1,800 pounds per day oxidazable nitrogen on the same basis with an adjustment for reduced efficiencies of treatment facilities in cold weather. The program also provides for operation of the anaerobic pond in such a manner as to provide aerobic treatment of the effluent from the pond. The Belle Plant has informed the State of their intent to meet the requirements of Phase III.

RECOMMENDATIONS

It is recommended that the following pollution control steps be initiated by the Company as soon as possible:

1. Du Pont take further precautions against the possibility of spills entering the river, particularly with respect to ammonia, since large quantitites are manufactured and stored at the plant site.
2. Du Pont makes every possible effort to further separate process wastes from cooling water, particularly from the general plant outfall, No. 017, and route these wastes to the aerobic treatment plant.
3. Steps be taken immediately toward treatment for the removal of 65 percent of the nitrogen from waste streams in accordance with the original Phase III general requirements.

4. Toxicity of effluents be reduced at least to the point that no discharge, undiluted, exceeds the 96-hour TL_m.
5. BOD_5 discharge loads be reduced at least to a total of no more than 2,600 lbs/day in order for the Kanawha River to meet the DO criteria of 4 mg/l at the existing seven-day, once-in-ten-year low flow.

KANAWHA RIVER

INVESTIGATION OF WATER QUALITY

AND

WATER POLLUTION CONTROL PRACTICES

B

VOLUME II

REPORTS OF INDUSTRIAL INVESTIGATIONS

ON SEVEN INDUSTRIES

B.
Union Carbide Corporation
Chemicals and Plastics
South Charleston Plant
South Charleston, West Virginia

and

South Charleston Sewage Treatment Company
South Charleston Waste Treatment Plant
South Charleston, West Virginia

United States Environmental Protection Agency

Office of Enforcement and General Counsel

National Field Investigations Center - Cincinnati

and

Region III - Philadelphia

July, 1973

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UNION CARBIDE CORPORATION, CHEMICALS AND PLASTICS AND SOUTH CHARLESTON SEWAGE TREATMENT COMPANY

SOUTH CHARLESTON, WEST VIRGINIA

GENERAL PLANT DESCRIPTION

The Union Carbide South Charleston Plant is located on the Kanawha River between river mile points 54.7 and 56.1. The plant occupies all of Blaine Island, about 1 1/4 miles long and 1.1 miles of the adjacent south river shore (left bank facing downstream). In addition, the plant has two separate storage facilities on 0.5 miles of the adjacent north shoreline. The storage facilities are in the City of Charleston, while the remainder is in the City of South Charleston.

The wastewater treatment facility, a joint venture of the plant and the City of South Charleston, occupies about 0.14 mile of the south shore, just upstream from the main plant property. The total area of the plants is 230 acres, all developed. Figure 1 shows the general layout.

The South Charleston Plant, known as the nation's first petro-chemical plant, began operations in 1925. Peak employment was 4,200. Employment now is approximately 2,100. The principal buildings include numerous chemical production facilities, textile fibers and vinyl resins plants, two power plants, a large

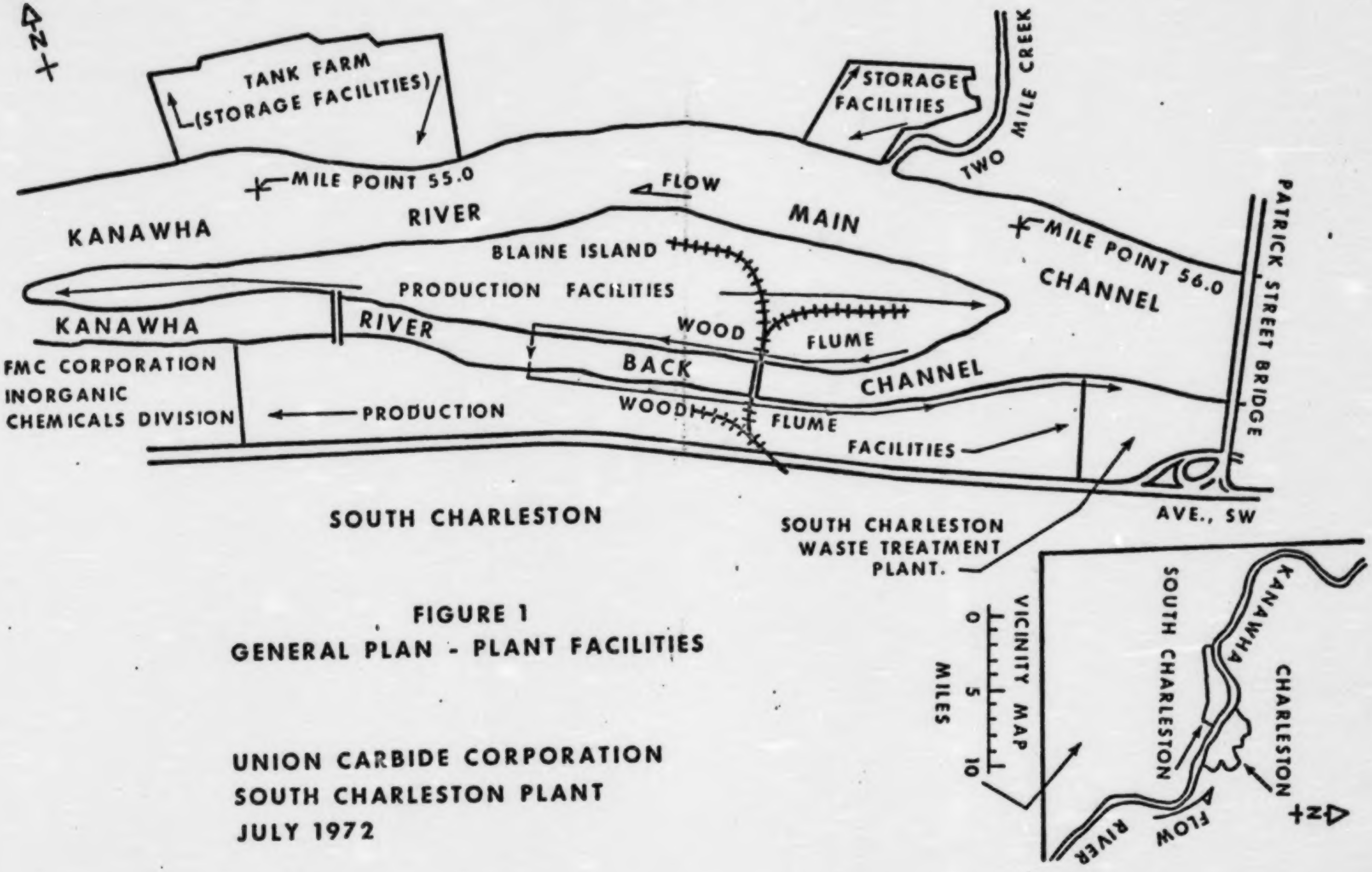

N
TANK FARM
(STORAGE FACILITIES)
STORAGE
FACILITIES
TWO MILE CREEK
MILE POINT 55.0
FLOW
KANAWHA
RIVER
MAIN
CHANNEL
MILE POINT 56.0
PATRICK STREET BRIDGE
BLAINE ISLAND
PRODUCTION FACILITIES
WOOD
FLUME
KANAWHA
RIVER
BACK
CHANNEL
FMC CORPORATION
INORGANIC
CHEMICALS DIVISION
PRODUCTION
WOOD
FLUME
FACILITIES
AVE., SW
SOUTH CHARLESTON
SOUTH CHARLESTON
WASTE TREATMENT
PLANT.
VICINITY MAP
0
5
10
MILES
KANAWHA
CHARLESTON
SOUTH CHARLESTON
FLOW
RIVER
N

FIGURE 1
GENERAL PLAN - PLANT FACILITIES

UNION CARBIDE CORPORATION
SOUTH CHARLESTON PLANT
JULY 1972

automated warehouse, the plant laboratory, and a ten story office building.

Representative organic chemical products have been acids, alcohols, aldehydes, esters, ethers, plasticizers, glycols, monomers, polyols, and surfactants. Products made earlier which have been discontinued at the plant include ethylene oxide, propylene oxide, polyethylene, and crotonaldehyde.

Principal raw materials have been natural and refinery gases which are cracked to produce ethylene, propylene, acetylene, and hydrogen. Subsequent processing involves mixing with other raw materials such as air, water, chlorine, etc.

More than 400 chemicals are manufactured in the continuous production facilities. Operations are around-the-clock, 365 days per year. Figures for total quantity and value of products shipped are not available. It is known that intermediates and final production (products shipped) total approximately 6,000,000 pounds per day. The plant currently produces the chemicals listed in Table 1.

WATER USAGE

Water use in the plant for the year 1971 is indicated in the flow diagram of Figure 2 and is compared with the earlier and higher water use of 1963. Of the total 222 mgd intake in 1971, 208 mgd or 94 percent was untreated cooling water discharged

Table 1

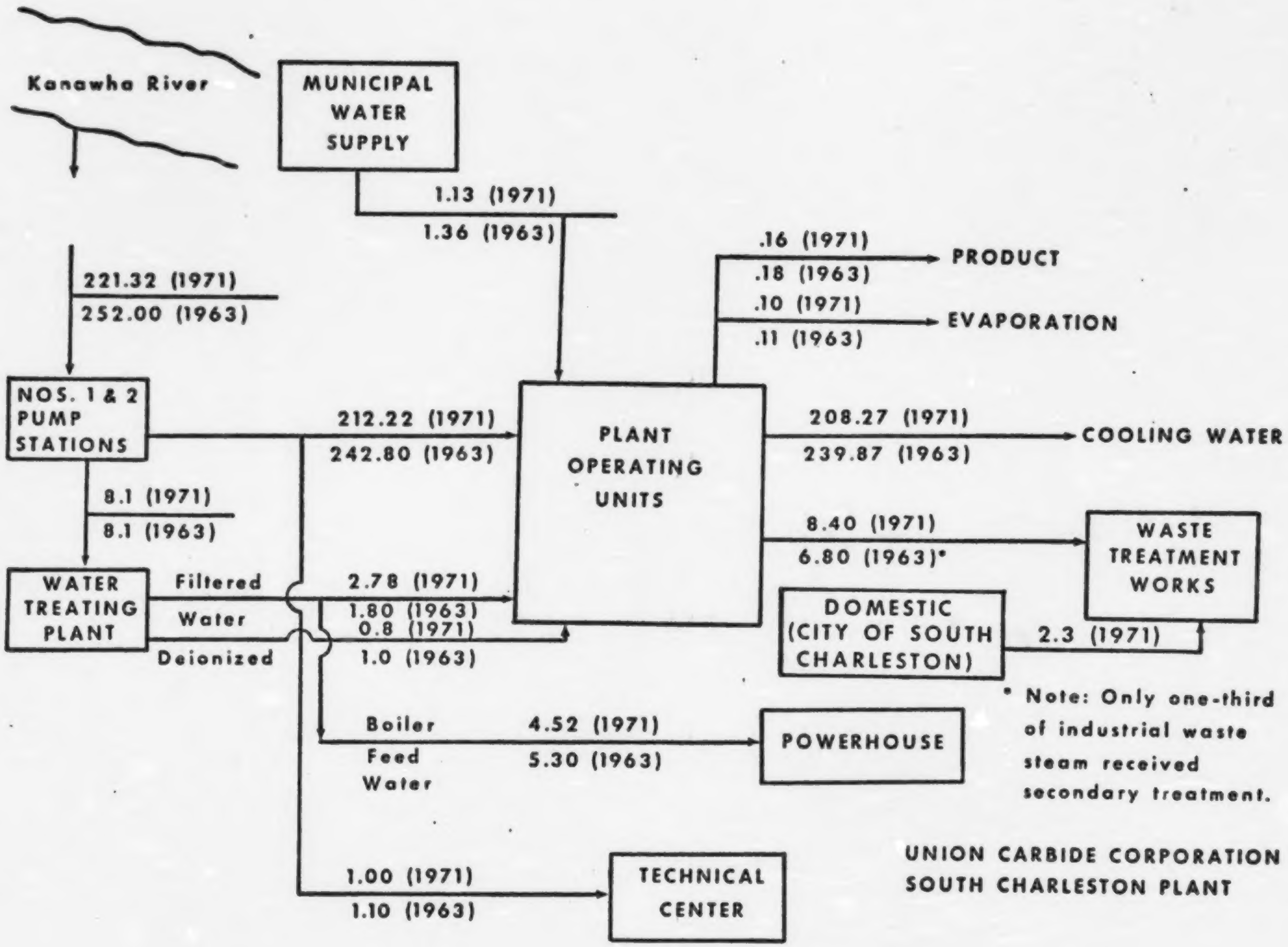
PRODUCTS OF THE UNION CARBIDE SOUTH CHARLESTON PLANT

Products	Examples	Uses	UCC Brand Names
Acids	Acetic, valeric, isopentanoic	Intermediates for esters, anhydrides, amides, peroxides, metallic salts, and as a solvent.	NIACET
Alcohols	Butanol, isobutanol, methyl amyl alcohol	Solvents, intermediates for aldehydes, ketones, acids, esters, plasticizers, lubricants, surfactants, and oil additives.	SYNASOL, ANHYDROL
Aldehydes	2-ethylhexaldehyde, hexaldehyde, pentaldehyde, isobutyraldehyde	Intermediates for acids, alcohols, amines, pharmaceuticals, rubber accelerators, resins, and dyes.	
Esters	Butyl acetate, ethyl acetate	Lacquer solvents, emulsion paints, intermediates for dyes, pharmaceuticals, insecticides, plasticizers, and as synthetic lubricants.	
Ethers	Butyl ether, isopropyl ether, vinyl ethyl ether	Extractants, solvents, & couplers.	
Plasticizers	FLEXOL Plasticizer TOF, FLEXOL Plasticizer 3 GH	Used with resins, lacquers, rubbers, to impart special properties.	FLEXOL
Glycol ethers	Butyl CELLSOLVE, Butyl CARBITOL, CELLOSOLVE	Solvents for lacquers, varnishes, dyes, paints, oils, insecticides, and soaps.	CELLOSOLVE

Table 1 (Cont.)

PRODUCTS OF THE UNION CARBIDE SOUTH CHARLESTON PLANT

Products	Examples	Uses	UCC Brand Names
Glycols	Ethylene glycol, diethylene glycol, propylene glycol	Solvents, antifreeze, deicing fluids, gas dehydration, humectants, air purification, and intermediates	PRESTONE SENTRY KROMFAX
Ketones	Methyl ethyl, methyl isoamyl	Solvents for resins, lacquers, pharmaceuticals, dewaxing compounds, and flotation agents	
Monomers	Vinyl acetate, vinyl chloride	To form polymers and copolymers for fibers, plastics, rubbers, paints, textile finishes, floor and shoe polishes, paper coatings, adhesives	BAKELITE NIACET
Nitrogen Compounds	Monoethanolamine, diethanolamine, isopropylamine, morpholine	Intermediates for soaps and dyes, emulsifying agents, corrosion inhibitors, insecticides, pharmaceuticals, fungicides, petroleum additives, wash and wear textile finishing resins, catalysts, detergents, cosmetics, shampoos, soluble oils, and fibers.	
Polyols	Polymer polyols NIAX LHT 34, Straight polyol LG-56	Production of flexible, semirigid and rigid urethane foams, elastomers, coatings, and adhesives.	NIAX
Surfactants	TERGITOLS Aerosol MA	Emulsifiers, detergents, and wetting agents	TERGITOL
Mixtures	Brake fluids, hydrolubes, antileak compounds	Solvents, curing agents, compounds, hydrolubes, brake fluids, corrosion inhibitors, de-icing fluids, insecticides,	CARBOSEAL, UCON, UGAR, MORLEX STABILENE, MYLONE


Kanawha River
MUNICIPAL WATER SUPPLY
1.13 (1971)
1.36 (1963)
221.32 (1971)
252.00 (1963)
NOS. 1 & 2 PUMP STATIONS
212.22 (1971)
242.80 (1963)
8.1 (1971)
8.1 (1963)
WATER TREATING PLANT
Filtered Water
Deionized
2.78 (1971)
1.80 (1963)
0.8 (1971)
1.0 (1963)
PLANT OPERATING UNITS
.16 (1971)
.18 (1963)
PRODUCT
.10 (1971)
.11 (1963)
EVAPORATION
208.27 (1971)
239.87 (1963)
COOLING WATER
8.40 (1971)
6.80 (1963)*
WASTE TREATMENT WORKS
DOMESTIC (CITY OF SOUTH CHARLESTON)
2.3 (1971)
Boiler Feed Water
4.52 (1971)
5.30 (1963)
POWERHOUSE
1.00 (1971)
1.10 (1963)
TECHNICAL CENTER

* Note: Only one-third of industrial waste steam received secondary treatment.

UNION CARBIDE CORPORATION
SOUTH CHARLESTON PLANT

FIGURE 2

WATER USE DIAGRAM - MGD (1963 and 1971)

to the river, and 6.1 mgd or three percent was processed in the waste treatment works. The remainder represents boiler feed water, use in the Technical Center, water in product, and evaporation loss.

Water use through 1972 is estimated to average about 70 percent of the 1971 figures, which would be in the range of 150 to 160 mgd.

WASTEWATER DISCHARGES AND WASTE SOURCES

The Union Carbide South Charleston Plant process wastewaters are routed through a redwood flume to the South Charleston Waste Treatment Plant. This is a joint venture of Union Carbide and the South Charleston Sanitary Board in the combined industrial and city wastewater treatment. The South Charleston Waste Treatment Plant effluent is discharged to the Kanawha at Mile Point 56.2. In 1971, the city portion averaged 2.2 mgd and the Union Carbide contribution averaged 6.1 mgd. In recent years the municipal flow has been increasing while the industrial and total flow have been decreasing.

Table 2 lists cooling water discharges described in the plant's Refuse Act permit applications. These streams also contain process wastewaters. The outfalls are located on the Kanawha River Back Channel between mile points 55.0 and 56.0 and at mile point 53.3 (Waid Hollow discharge).

TABLE 2

DISCHARGES, SOURCES AND FLOWS

Union Carbide Corporation - South Charleston Plant

(South Charleston Waste Treatment Plant Discharge Not Included)

Refuse Act Permit Application No.	Source Area	Flow - MGD Permit Application	During Survey
001 thru 008, 012, 018, 020 thru 022, 026, 029, 030, 034, 041, 043 thru 046, 049, 052, 055 thru 058, 066 thru 070, 073, 082 thru 090 (total 44 outfalls)	Surface runoff	normally dry	
019 and 077	Waste collection stations	no discharge	
009*	Water treatment backwash	0.4	(0.34)
011	Pumphouse-flushing traveling screen	-	
013		0.05	
014*	Misc. distillation - polyol processing	6.5	(8.62)
015*	" "	2.2	(1.98)
016		0.6	
017*	Liquid phase hydrogenation	7.1	(2.47)
023*	Fine chemicals and vinylite	25.5	(13.4)
024*	No. 2 CELLOSOLVE unit	4.7	(3.55)
025*	Vinyl resins and plasticizers	27.4	(17.83)
027		0.7	
028		0.04	
031*	Acetic esters	8.1	(4.58)
032*	Aldehyde and powerhouse	2.3	(2.77)
033*	No. 1 Pumphouse screen flushing	-	

---

* Outfalls sampled 3/14-15/72; flows at time of sampling in parentheses.

TABLE 2 (Cont.)

DISCHARGES, SOURCES AND FLOWS

Union Carbide Corporation - South Charleston Plant
(South Charleston Waste Treatment Plant Discharge Not Included)

Refuse Act Permit Application No.		Source Area	Flow - MGD	
			Permit Application	During Survey
035*		Aldehyde	2.7	(2.65)
036*		Merrill furnaces - aldehyde	4.0	(0.93)
037(1)		Crotonaldehyde	1.8	
038*		Aldehyde	2.7	(2.49)
039*		Acetaldehyde	7.5	(6.14)
040*		Butanol	14.0	(10.55)
042*		Butanol	4.1	(5.42)
047	Polyethylene process shut down Spring 1972		0.10	
048			1.4	
050		Gas separation	22.3	(0.52)
051			1.4	
053*		Gas separation	4.7	(0.52)
054			6.5	
059			0.5	
060			1.6	
061		Polyethylene	2.3	
062			0.1	
063			0.7	
064			0.07	
065			0.5	
071			0.1	
072		Dynel	0.7	
074*		Miscellaneous Chemicals	18.6	(17.15)
075*		Oxide Adducts and Powerhouse	6.1	(1.34)
076*		" " "	8.5	(6.51)

---

* Outfalls sampled 3/14-15/72; flows at time of sampling in parentheses.

TABLE 2 (Cont.)

DISCHARGES, SOURCES AND FLOWS

Union Carbide Corporation - South Charleston Plant
(South Charleston Waste Treatment Plant Discharge Not Included)

Refuse Act Permit Application No.	Source Area	Flow - MGD Permit Application	Flow - MGD During Survey
078		0.1	
079*	Oxide adducts & powerhouse	7.5	(4.13)
080*(1)	Composite drains	3.5	(2.73)
081		0.6	
091*	Ward Hollow (includes fly ash disposal)	4.0	(3.45)

---

* Outfalls sampled 3/14-15/72; flows at time of sampling in parentheses.

(1) Closed down by mid-1972.

The primary waste sources are the production units listed below, and their support activites, such as the steam plants.

Amines, Glycol Ethers, Miscellaneous Distrillation,
Glycol (077)

Chlorhydrin (124)

Oxide Adducts (167)

Polyols (106)

Hydrogenation (066)

Specialty Chemicals (115)

Plasticizers (125) (122)

Esters, CELLOSOLVE (121) (070)

Aldehyde, Butanol, Ketene (061) (063) (108)

Ethanol (045)

Latex (087)

Vinyl Specialty Resins (082)

Vinyl Solvent Resins (083)

Vinyl Dispersion Resins (085)

DYNEL Resin, Fiber, Staple (078) (098) (152-252)

Bulk Handling (585)

WASTE TREATMENT PROGRAM

Historical Development

Pollution abatement and waste treatment efforts at the Union Carbide South Charleston plant began in 1952-53 with the separation of cooling water from sanitary and process waste.

The West Virginia Department of Natural Resources and the Kanawha River Industrial Advisory Committee initiated Phase I of the Kanawha cleanup program in 1958 with the requirement for primary treatment of all industrial and domestic wastes and partial secondary treatment of industrial wastes. The 1958 base BOD_5 load for the South Charleston plant was established at 167,000 pounds per day. Phase I required a 40 percent reduction to 100,000 pounds per day.

The South Charleston Sanitary Board and the Union Carbide South Charleston Plant formed the South Charleston Waste Treatment Company in 1959. The design of the combined domestic and industrial waste treatment works for Phase I was completed in that same year, with the completion of construction in 1963.

With the completion of the Phase I program, the Kanawha River did not meet the minimum criteria and a Phase II program was established with a final implementation date of June 30, 1966. The date was later extended by the state. The BOD_5 load limitation for the South Charleston plant was 50,000 pounds per day.

Expansion of the South Charleston Waste Treatment Company's plant was completed, after many delays, in mid-1968. The plant, affected by startup difficulties, generally met the BOD_5 load limitation by mid-1969.

Phase II still did not achieve the water quality standards DO criteria and a Phase III program was initiated by the state in 1969 with an implementation date of December 31, 1972. The Phase III BOD_5 limit for the South Charleston plant was established as 85 percent reduction of the 1958 BOD_5 load (a limit of 24,900 pounds per day total discharge) and a maximum practicable reduction of nitrogen loadings. The BOD_5 limitation was met in 1971 by a higher treatment plant efficiency, tighter process control and the shutdown of certain production units. Additional pollution control improvements are under construction and will result in a lower BOD discharge level as facilities are completed in 1973-74.

The total waste load disposition for the year 1971 is shown in Table 3. The Phase III limit of 24,900 BOD_5 discharge to the Kanawha River was achieved well ahead of the December 31, 1972, compliance date.

Existing Waste Treatment Facilities

Incineration and Landfill

The equivalent of 149,400 pounds per day BOD_5 is burned in the plant steam boilers. Solid chemical wastes with a BOD_5 equivalent of 15,000 pounds per day are transported to the Goff Mountain Landfill, operated by the Union Carbide Institute plant. Inert solid wastes are landfilled in the "Fillmont" area north of the Union Carbide Technical Center and south of FMC Inorganic Chemicals Divisions's "Beaver Pond."

TABLE 3

DISPOSITION OF THE 1971 TOTAL WASTE LOAD - UNION CARBIDE SOUTH CHARLESTON PLANT

Pounds BOD_5/Day Raw Load	Disposal	Pounds BOD_5/Day Discharged to the River
149,400	Plant Steam Boilers	0
15,000	Chemical Landfill	0
53,000	South Charleston Sewage Treatment Plant	6,700
7,500	Cooling Water (untreated)	7,500
10,700	Ward Hollow (untreated)	10,700
235,600		24,900

Fly ash and wastewater treatment plant industrial sludge are pumped to the Ward Hollow disposal pond south of the Technical Center. The overflow from the pond which includes other wastewaters had been discharged to Davis Creek but was routed to the wastewater treatment plant in late 1972.

Wastewater Disposal

Wastewater Treatment Plant Description

Process wastewaters from the Union Carbide South Charleston plant are routed to the South Charleston Waste Treatment Works, which also treats the wastes from the City of South Charleston. The plant is owned by the City of South Charleston and operated by the South Charleston Sewage Treatment Company.

The general layout and a flow diagram of the South Charleston Waste Treatment Works are shown in Figure 3. The municipal wastes and industrial wastes receive primary treatment in the plant before being combined for further treatment.

The domestic system is designed to handle an ultimate South Charleston population of 42,500, and to provide for an average domestic flow of 5.8 million gallons per day. The sewage flows through a collection system which covers the entire length of the city. When it enters the plant, it first is pumped through mechanical cutters to a flow measuring flume and then into a 12,000 gallon grit basin where coarse material, such as

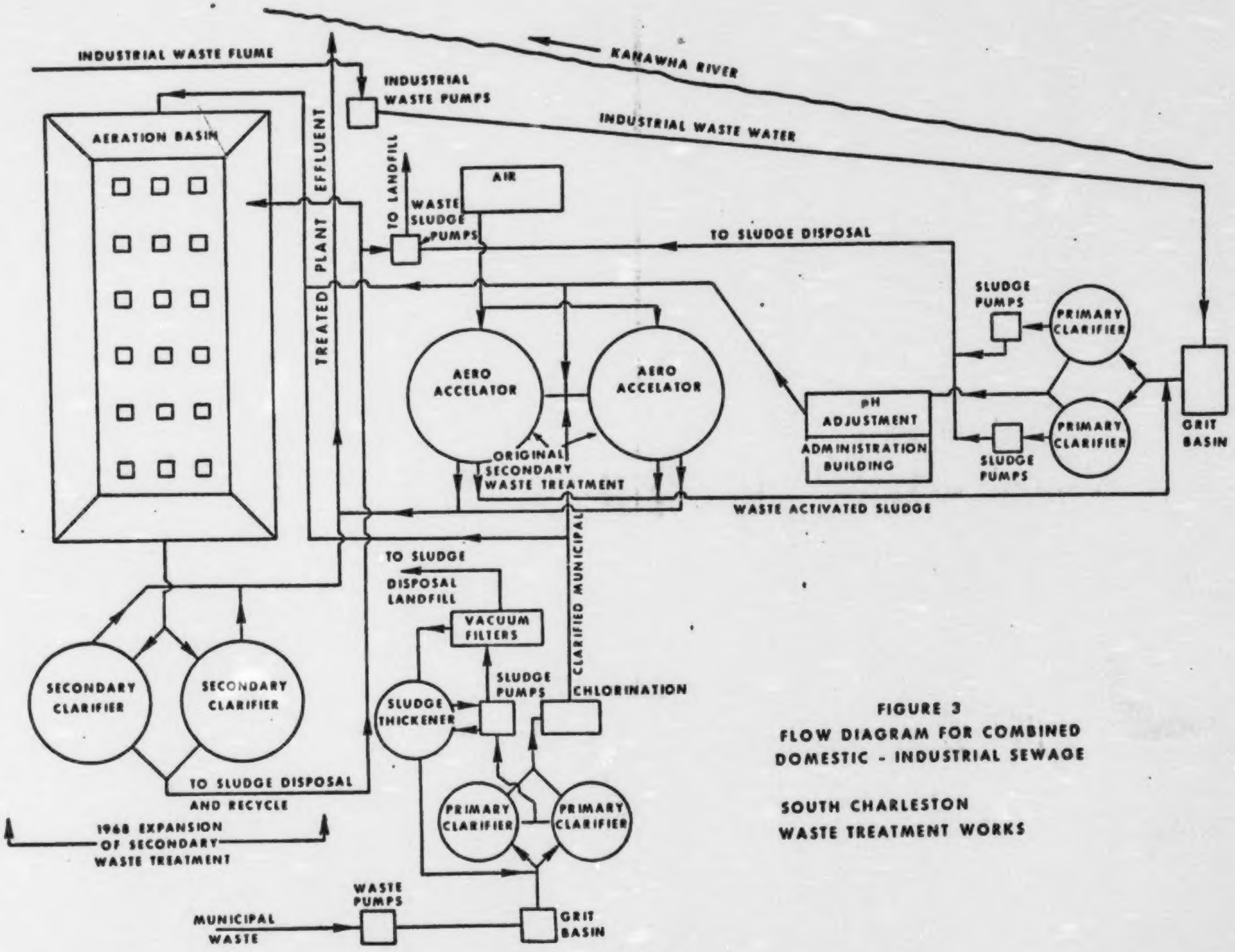

INDUSTRIAL WASTE FLUME
KANAWHA RIVER
INDUSTRIAL WASTE PUMPS
INDUSTRIAL WASTE WATER
AERATION BASIN
TREATED PLANT EFFLUENT
TO LANDFILL
WASTE SLUDGE PUMPS
AIR
TO SLUDGE DISPOSAL
SLUDGE PUMPS
PRIMARY CLARIFIER
PRIMARY CLARIFIER
SLUDGE PUMPS
GRIT BASIN
AERO ACCELATOR
AERO ACCELATOR
pH ADJUSTMENT
ADMINISTRATION BUILDING
ORIGINAL SECONDARY WASTE TREATMENT
WASTE ACTIVATED SLUDGE
CLARIFIED MUNICIPAL
TO SLUDGE DISPOSAL LANDFILL
VACUUM FILTERS
SLUDGE THICKENER
SLUDGE PUMPS
CHLORINATION
SECONDARY CLARIFIER
SECONDARY CLARIFIER
TO SLUDGE DISPOSAL AND RECYCLE
1968 EXPANSION OF SECONDARY WASTE TREATMENT
PRIMARY CLARIFIER
PRIMARY CLARIFIER
MUNICIPAL WASTE
WASTE PUMPS
GRIT BASIN

FIGURE 3
FLOW DIAGRAM FOR COMBINED
DOMESTIC - INDUSTRIAL SEWAGE

SOUTH CHARLESTON
WASTE TREATMENT WORKS

gravel, is removed. Slowest settling solids are then removed in the two 64-foot diameter municipal primary clarifiers. The clear overflow, after chlorination to remove undesirable bacteria, goes to the secondary treatment system. The solids are further concentrated in a 45-foot diameter sludge thickener. The thickened sludge is filtered on two 8-foot diameter by 12-foot long rotary vacuum filters. The filter cake is buried in a landfill site.

The industrial process wastewater is collected in redwood flumes which run the length of Blaine Island and along the riverbank on the mainland section of the South Charleston Union Carbide plant (see Figure 1). Wastewater from the Blaine Island flume enters a sump from where it is pumped to the mainland flume. The mainland flume flows to the wastewater treatment plant. As the wastewater enters the plant, it is pumped to a grit basin for removal of coarse solids.

The industrial system is designed to handle 11.5 million gallons per day of flow. The two industrial primary clarifiers are the same size as the domestic clarifiers. The industrial sludge is not thickened as it pumped to a disposal pond where it is mixed with fly ash.

Clarified wastewater from the industrial stream flows to a three-basin pH control system where the pH is adjusted with the addition of acid or alkali. A computer controls the flow of additives so that the emerging pH is maintained close to 9.5; this provides enough alkalinity to enable the microorganisms to work in a substantially neutral medium.

Approximately one-third of the combined industrial and municipal wastewater flows to the original secondary treatment system which is comprised of two Aero-accelators. Each accelator is ninety feet in diameter and over 24 feet deep with a liquid capacity of about 1,130,000 gallons. A 150 horsepower motor-driven agitator in each accelator stirs the mixture of wastewater and biological growth. Three compressors provide sufficient oxygen for the biological growth. The air is pumped into the bottom of the Aero-accelators through sparger pipes mounted under the agitators. The flow is proportioned to provide the wastewater with an average of 7 1/2 hours in the aeration zone and an averge 2 1/2 hours in the recirculation and sedimentation zones.

The remaining two-thirds of primary clarified wastewater is pumped to the aeration basin. The aeration basin is the 1968 addition to secondary treatment system which measures 202 feet wide by 347 feet long at the top and has sloping sides to a depth of 18 feet. Total liquid volume is 6,450,000 gallons, sufficient to provide an average of about ten hours aeration time for biodegradation of the feed. The sides and bottom are lined with a layer of cement-fly ash mixture, which prevents erosion from the circulating liquid

Agitation and aeration are provided by 18 surface aeration units, each mounted on a concrete platform supported by four concrete columns resting on concrete filled steel piles. Each aeration unit is driven by a 100 horsepower motor. The treated flow from the new basin passes to two final clarifiers where the sludge is collected by a revolving tubular sludge removal mechanism. The two secondary clarifiers are each 95 feet in diameter, 12 feet deep, and allow approximately two hours for separation of the sludge. The majority of the sludge is returned to the basin to maintain biological activity, but part is withdrawn and pumped to the Ward Hollow fly ash lagoon. The treated effluent from the secondary clarifiers is combined with the Aero-accelator effluent and is discharged to the river through the outfall structure.

Cooling Water

At the time of the survey there were 45 active outfalls. Since that time the number has been reduced to 29 as a result of closing down certain production units and routing additional wastewater streams to the treatment plant. There were 45 "dry outfalls" at the time of the survey, mainly surface water drains. This number has been increased by unit shutdowns since the survey.

All of the discharges, except that from the wastewater treatment plant, are classified by the company as cooling water outfalls. Most of them receive either intermittent or continuous wastes from spills, leaks, upsets, etc., of the chemical processes.

The cooling water dishcarges, sources, and flows are listed in Table 2. Summary BOD_5 loadings/discharges are shown in Table 4. The untreated cooling water discharges represented 32 percent of the total BOD_5 load to the Kanawha River in 1971.

Monitoring and Control Practices

All Waste Treatment Plant influent streams and the plant effluent stream are sampled regularly, as are various intermediate points. The sampling points, analyses performed, and frequency are shown in Table 3. The fully equipped laboratory at the treatment works performs these analyses. Data reported to the state include analyses of raw wastewaters from domestic and industrial sources, primary treated domestic and industrial wastes, combined influent wastes to the secondary treatment units, effluent of the secondary clarifiers and combined total plant effluent. Threshold odor is measured routinely on certain treatment works streams by the Union Carbide South Charleston plant laboratory.

Control practices at the treatment works are as follows: The Aero-accelator mixed liquor suspended solids (MLSS) is ordinarily maintained in the range of 5,500 to 7,500 mg/l. A fair

TABLE 4

SOUTH CHARLESTON SEWAGE TREATMENT CO.
LABORATORY ANALYSIS SCHEDULE

	BOD_{20}	BOD_5	COD	TOTAL SOLIDS	SUSP. SOLIDS	SETTLE. SOLIDS	TOTAL NITROGEN	AMMONIA NITROGEN	PO_4	CHLORIDE	OXYGEN UPTAKE	COLIFORM	MICRO-SCOPIC EXAM	pH	DO	TEMP.	FLOW	TOTAL CARBON
I. INDUSTRIAL INFLUENT	M,Th	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	--	-------	------	--------	-----	CRR*	--	CRR*	CRR*	CRR*
II. INDUSTRIAL CLARIFIED	----	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	------	--------	--	-------	------	--------	-----	---		---	---	---
III. DOMESTIC INFLUENT	----	M,W.	M,W.	M,W.	M,W.	M,W.	Th.	Th.	Th.	-------	------	--------	-----	CRR*	--	CRR*	CRR*	---
IV. DOMESTIC CLARIFIED		M,W.	M,W.	M,W.	M,W.	M,W.	------	--------	--	-------	------	--------	-----	---	--	---	---	---
V. FEED TO ACCELATORS	----	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	-----	-----	-----	------	--------	M,T,W, Th,F.	-------	------	--------	-----	S,M,T, W,Th,F,S.	--	---	---	---
VI. FEED TO BIG BASIN	----	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	-----	-----	-----	------	--------	M,T,W, Th,F.	-------	------	--------	-----	---	--	---	---	---
VII. EAST ACCELATOR MIXED LIQUOR	----	-------	-------	-----	M,T,W,Th, F.	M,T,W,Th, F.	------	--------	--	-------	M,T,W,Th, F.	--------	M,W,F.	CRR*	CRR*	Log Sheets	---	---
VIII. WEST ACCELATOR MIXED LIQUOR	----	-------	-------	-----	M,T,W,Th, F.	M,T,W,Th, F.	------	--------	--	-------	M,T,W,Th, F.	--------	M,W,F.	CRR*	CRR*	Log Sheets	---	---
IX. BIG BASIN MIXED LIQUOR	----	-------	-------	-----	M,T,W,Th, F.	M,T,W,Th, F.	------	--------	--	-------	M,T,W,Th, F.	--------	M,W,F.	CRR*	CRR*	Log Sheets	---	---
X. EAST ACCELATOR EFFLUENT	----	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	------	M,T,W,Th, F.	M,T,W, Th,F.	-------	------	--------	-----	---	--	---	---	---
XI. WEST ACCELATOR EFFLUENT	----	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	Th,F,S,S, M,T,W.	Th,F,S,S, M,T,W.	------	M,T,W,Th, F.	M,T,W, Th,F.	-------	------	--------	-----	---	--	---	---	---
XII. FINAL CLARIFIED EFFLUENT	----	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	------	M,T,W,Th, F.	M,T,W, Th,F.	-------	------	--------	-----	---	--	---	---	---
XIII. OUTFALL	M,Th.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	Th.	------	F.	-----	---	--	---	---	---
XIV. RECYCLE SLUDGE	----	------	-------	-----	M,T,W,Th. F.	-----	------	-------	--	-------	------	-------	-----	---	--	---	---	---
XV. FILTER CAKE			% Solids - Tuesday and Thursday.															
XVI. PRIMARY IND. SLUDGE																		
XVII. PRIMARY DOM. SLUDGE																		
XVIII. THICKENED SLUDGE			Suspended Solids - Tuesday and Thursday.															

* Control Room Recorder

average would be approximately 6,000 mg/l. The Aero-accelator mixed liquor volatile suspended solids (MLVSS) is usually 85 to 90 percent of the MLSS,

The surface aeration basin MLSS is maintained generally in the range of 5,000 to 7,000 mg/l. The percent volatile is in the range of 82 to 88 percent.

Since the Aero-accelators are internally clarified activated sludge basins, the sludge recycle rate is not measured. The recycle rate will vary with the aeration zone port openings and the aeration rate. The ports are operated about three-fourths open.

The recycle rate at the surface aeration basin is usually in the range of 3,500 to 4,200 gpm. The recycle rate as a percentage of primary combined wastewater feed is usually 80 to 100 percent.

Samples of circulating sludge taken from the bottom of the Aero-accelator peripheral zone show its MLSS concentration to be slightly higher than in the aeration zone, but seldom as much as ten percent higher. The solids concentration of the return sludge from the final clarifiers to the surface aeration basin is ordinarily 9,000 to 12,000 mg/l.

The air supplied to each Aero-accelator varies with the organic loading. A good average would be 3,700 scfm. The mixed liquor dissolved oxygen near the top of the aeration zone is held in the range of 1.0 to 2.5 mg/l. Each Aero-accelator can be supplied with 4,500 scfm if the organic loading requires it.

The dissolved oxygen level in the surface aeration basin is controlled by starting and stopping the 100 horsepower surface aerators. With current loadings the number of aerators in use is usually in the range of twelve to sixteen. The five 75 horsepower bottom mixers help keep the solids suspended, so the number of aerators on line is governed primarily by the DO level in the basin. The DO in the upper three feet of mixed liquor is generally held in the 3.0 to 5.0 mg/l range. Tests have shown this provides at least 0.5 mg/l at the lower depths.

The Sludge Volume Index (SVI) of the Aero-accelator and surface aeration basin mixed liquors generally falls in the range of 50 to 120. The laboratory data on mixed liquors for the month of December, 1971, indicates an average of 95.

Depth of the sludge blanket in the surface aeration basin final clarifiers is not regularly measured. Occasional measurements with a photocell device show the blanket is generally seven to ten feet below the surface.

The depth of the blanket in the peripheral zone of the Aero-accelators is regularly measured. It is generally five to seven feet below the surface.

Untreated wastewater (cooling water) streams flowing continuously are each equipped with a composite sampler which collects a representative sample of the discharge over a 24-hour period. The Waste Treatment Works discharge monitoring system also includes a 24-hour composite sampler. The Ward Hollow discharge had been sampled in that manner prior to its re-routing to the treatment plant.

The cooling water samples are analyzed daily for total carbon. BOD_5, suspended solids, total solids, and chloride are determined from weekly composites. If the quality of sewered cooling water is below the standards established by the Union Carbide Environmental Protection Department, the responsible production unit is directed to take corrective action. Gas chromatograph analyses are made on any samples above the standard total carbon values in efforts to pinpoint the source of the leak, spill, etc. Three outfalls are monitored with foam detector instrumentation. Continuous TCA (total carbon analyzer) monitor sample stations are located at the Waste Treatment Works discharge and at the industrial wastewater flume.

The Union Carbide Waste Load Report (monthly) to the State includes data on average daily loads of BOD_5, suppended solids, and total solids. These are reported in pounds per day for total cooling water outfalls (not for individual outfalls), treatment plant, and overall plant total.

Removal Efficiency

The overall Union Carbide-South Charleston raw and discharged BOD_5 loads are shown in Figure 4. The total load discharged to the river includes the municipal load, but the municipal load is very small compared with the industrial load, generally ranging between 200 and 1,000 pounds per day to the river during the past three years. During 1971, the municipal load to the river ranged between monthly averages of 170 pounds per day and 620 pounds per day, or less than five percent of the total wastewater treatment plant load to the river.

A summary of raw and discharged BOD_5 loads for 1969, 1970, and 1971 is shown in Table 5.

As shown, the total raw waterborne BOD_5 load generated at the Union Carbide South Charleston plant decrease by more than fifty percent in the three years 1969-1971. During the same period, BOD_5 removal efficiency increased. In 1971, the total plant waterborne BOD_5 removal was 65 percent while the efficiency of the treatment plant was 87 percent. Treatment plant efficiency varied during the year with lower efficiencies in winter and higher removals in summer. During 1971, WWTP efficiency ranged from a monthly average of 74 percent in January to 93 percent in June.

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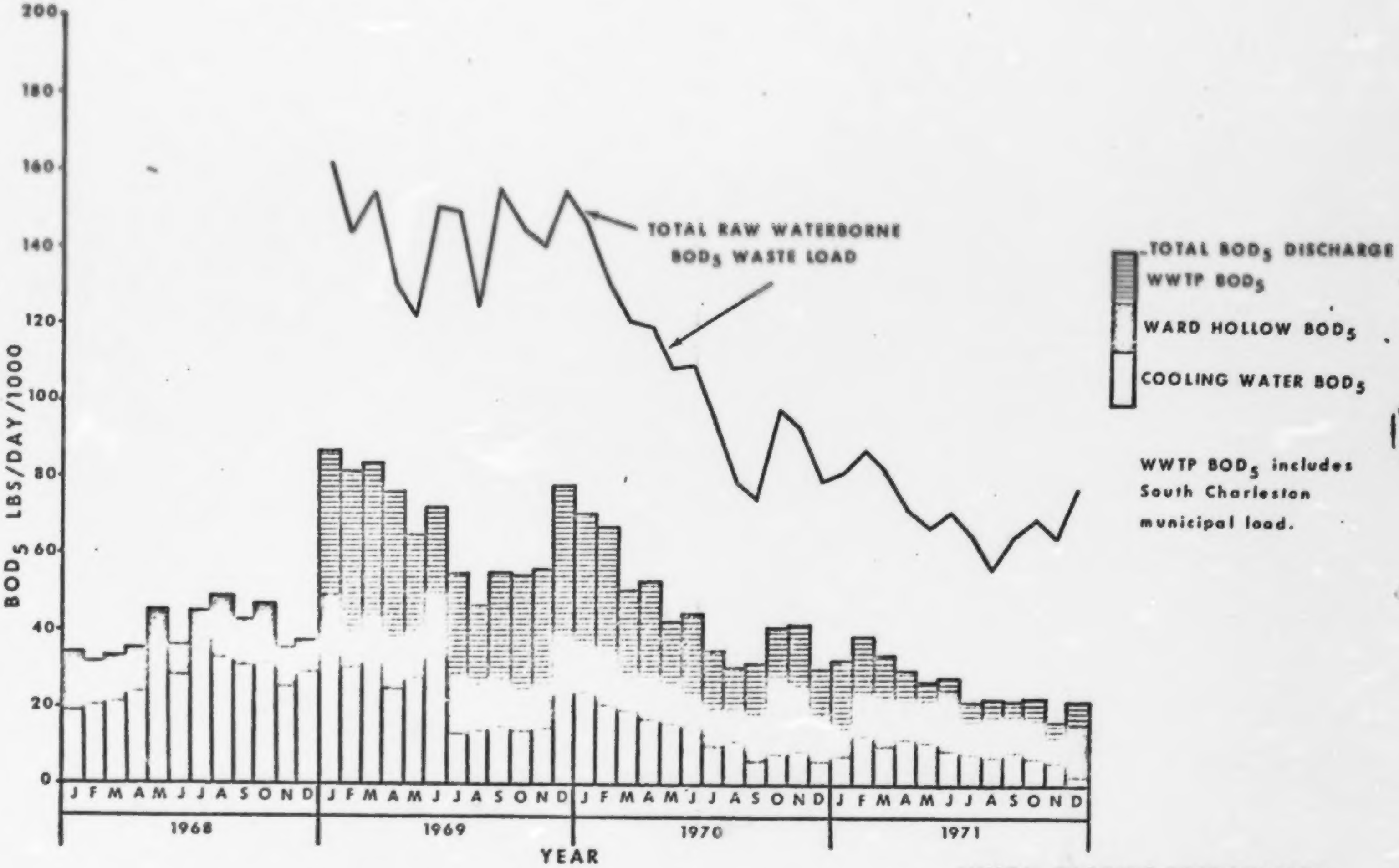

FIGURE 4
BOD$_5$ WASTE LOADS

UNION CARBIDE CORPORATION
SOUTH CHARLESTON PLANT
SOUTH CHARLESTON
WASTE TREATMENT WORKS (WWTP)

Table 5

SUMMARY OF BOD_5 LOADING DATA FOR UNION CARBIDE AT SOUTH CHARLESTON, 1969 THROUGH 1971

	Raw BOD_5 (lbs/day/1000)			
Year	Cooling Water	Ward Hollow	WWTP Influent	Total Raw Load
1969	23	13	108	144
1970	13	12	78	103
1971	8	10	53	71

	Discharged BOD_5 (lbs/day/1000)			
Year	Cooling Water	Ward Hollow	WWTP Influent	Total Raw Load
1969	23	13	31	67
1970	13	12	19	44
1971	8	10	7	25

	BOD_5 Removal (%)	
Year	Total Plant Removal	WWTP Removal
1969	53%	71%
1970	57%	76%
1971	65%	87%

With the routing of the Ward Hollow discharge to the treatment plant in 1972, the expected additional reduction of the Union Carbide-South Charleston BOD_5 load to the river is 10,000 x .87 = 8700 pounds per day, a signficant reduction.

Spill Potential

The equivalent of spills occurs regularly at the South Charleston Waste Treatment Works and the industrial waste inlet under certain high water conditions. The waste inlet system utilizes an open top flume which is flooded periodically by high river waters. Such flooding is not infrequent, as the following tabulation shows:

Occurrence of Flume Flooding

1961	12/19, 12/20, 2/26, 2/27, 2/28, 31/1
1962	1/8, 2/27, 2/28, 3/1, 3/22, 3/23
1963	3/12, 3/13, 3/16, 3/17, 3/18, 3/19, 3/20, 3/21, 3/26
1964	3/4, 3/5, 3/6, 3/7, 3/8, 3/9, 3/10, 3/16
1965	4/12, 3/26, 3/27, 3/28, 2/9
1966	5/1, 5/2, 5/3, 5/4
1967	3/7, 3/8, 3/14, 3/15, 3/16, 5/15, 5/16
1968	3/13
1969	12/30, 12/31, 8/21
1970	1/1, 1/3, 1/4, 2/16
1971	None
1972	2/24, 2/25, 2/26, 2/27, 2/28, 2/29, 3/1, 3/2, 3/3, 3/4

The average number of days per year during which the flooding has occurred is approximately five. Ten consecutive days of flooding occurred in 1972. These are periods during which the raw waste load is, in effect, by-passed to the river. This potential will continue until late 1973 when the installation of a new covered flume at a five foot higher elevation will be completed. This is expected to reduce the flooding occurrence to an average of 26 hours per year.

The potential for pollution through spills in the manufacturing areas has been reduced through the following efforts:

a. 24-hour composite samplers at all continuous flow outfalls.

b. Weekly check of dike valves (dike valves kept closed).

c. Visual inspection of all outfalls by Utilities Foreman on each shift.

d. Diversions of certain pollution areas in cooling water system to polluted sewer system.

Data on spill frequencies, quantities, etc., have not been compiled. It is known that in 1971 one incident occurred which resulted in a citation and a fine of $500. The U. S. Coast Guard detected a forty gallon spill of Estanol during barge operations. Known spills have been infrequent as indicated by citations issued.

Some, but not all, of the surface water drains are from controlled dike areas, from which contaminated water can be directed to the wastewater treatment plant.

The potential for pollution of the receiving water by actual spills in the manufacturing and storage areas is judged to be moderate on the basis of the record, and the observed diking for tanks which hold toxic materials.

Future Plans

Future plans and current activity as related to recent problems at the South Charleston Waste Treatment Plant are tabulated below:

Problem	Solution
Flooding of industrial raw wastewater flume.	Replacement of the flume at a five-foot higher elevation is scheduled for completion by the end of 1973. It is estimated that the revised collection system will reduce flooding occurrence to an average of 26 hours per year.
Shutdown requirements for maintenance at industrial wastewater neutralization system.	A by-pass around the neutralization system is scheduled for completion by June, 1973.
Marked fluctuation in industrial influent loading and lack of storage facilities for industrial waste.	Three 1,000,000 gallon surge tanks have been installed adjacent to the WTW to reduce the peak fluctuations in influent BOD. These tanks will also be of value in avoiding discharge to the river in event of a power outage or breakdown of criical equipment.

The tanks are being used in a startup phase (May, 1973).	An experimental biomonitor device is being installed to provide diversion of excessive waste chemicals.
High suspended solids in the final clarifier effluent, and foaming in the secondary system aeration tanks.	Installation of the following facilities was compiled in early 1973: (a) clarifier spray system; (b) clarifier scum baffles; (c) submerged outlet for surface aeration basin; (d) improved flow divider for distribution of surface aeration basin effluent between the two final clarifiers; and (e) bulk antifoam storage and feed system for better foam control in the surface aeration basin. An intensive investigation is being made of sources of foam producers within the chemical plant. An on-line foam detector has been developed and is being used in this investigation.
Excessive stormwater flows which periodically result in by-passing of the chlorinated domestic primary effluent to the Kanawha.	This problem has received some study at the waste treatment works and will be receiving more. The South Charleston Sanitary Board has been advised that considerable storm water enters the sanitary sewer system and their maintenance crews are on the lookout for places of stormwater entry.
Equipment outages caused by electrical problems.	An improved electrical distribution system will be completed by June, 1973.

NFIC-CINCINNATI FIELD SURVEY

Sampling

In order to confirm and/or ascertain the magnitude of loadings to the river, source areas, and effectiveness of the treatment system at Union Carbide-South Charleston, the EPA conduced at 24-hour sampling survey of the plant intake water, waste treatment plant influent and effluent, principal cooling water outfalls and the effluent from Ward Hollow on March 13, 14, and 15, 1972. Two-hour grab samples were composited over a period of 24-hours for each outfall and split with the company and the West Virginia Division of Water Resources.

Selection of the outfall sample points listed in Table 6 was generally on the basis of the higher flow discharges, greater than 1 mgd as indicated in Refuse Act Permit Applications. The large analytical load for the overall Kanawha Study precluded the checking of all outfalls of the larger plants. Approximately 90 percent of the total flow from all Union Carbide-South Charleston outfalls was monitored by sampling at the points selected.

Toxicity checks were limited, again because of the large Kanawha Study total load, to three outfalls. Wastewaters discharged from the South Charleston Waste Treatment Plant and two untreated discharges to the river were used in static bioassays. The two highest flow untreated waste streams, from the Vinylite Area and the Acetylene and Miscellaneous Chemicals Area, were selected.

Analysis

Comparison of Union Carbide, State, and NFIC-Cincinnati Analysis

The results of the NFIC-Cincinnati survey, converted to pounds per day, are listed in Table 6. State and Union Carbide results are also included where the analyses were performed.

Table 6

RESULTS OF UNION CARBIDE SOUTH CHARLESTON PLANT SAMPLING MARCH 13, 14, and 15, 1972

Analyses and Flows Converted to Net Loads in lbs/day

Outfall RAPP No.	Flow MGD	BOD$_5$			BOD$_{20}$			COD			TOC			Total Solids			Susp. Solids			TKN			NH$_3$-N			Phenol			Oil & Grease		
		Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA
004	0.34	-	-	-	-	-	-	-	-	57	-	-	20	-	-	613	-	-	417	-	-	1.7	-	-	-	-	-	-	-	-	-
014	8.62	-	-	164	-	-	-	-	-	575	-	-	216	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
015	1.98	-	-	147	-	-	-	-	-	1106	-	-	231	-	-	660	-	-	-	-	-	3.3	-	-	-	-	-	-	-	-	-
017	2.47	-	-	42	-	-	-	-	-	21	-	-	-	-	-	-	-	-	-	-	-	2.1	-	-	-	-	-	-	-	-	-
023	13.4	-	-	341	-	-	-	-	-	336	-	-	112	-	-	-	-	-	-	-	-	67.2	-	-	-	-	-	-	-	-	-
024	3.55	-	-	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
025	17.83	-	-	460	-	-	-	-	-	1338	-	-	149	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
031	4.58	-	-	57	-	-	-	-	-	38	-	-	38	-	-	-	-	-	-	-	-	7.6	-	-	-	-	-	0.7	-	-	-
032	2.77	-	-	177	-	-	-	-	-	2379	-	-	139	-	-	3234	-	-	2010	-	-	4.6	-	-	-	-	-	-	-	-	-
035	2.65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.2	-	-	-	-	-	-	-	-	-
036	0.93	-	-	6	-	-	-	-	-	8	-	-	8	-	-	-	-	-	8	-	-	0.8	-	-	-	-	-	-	-	-	-
038	2.49	-	-	46	-	-	-	-	-	21	-	-	62	-	-	208	-	-	-	-	-	2.1	-	-	-	-	-	-	-	-	-
039	6.14	-	-	599	-	-	-	-	-	-	-	-	102	-	-	1843	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
040	10.55	-	-	103	-	-	-	-	-	-	-	-	-	-	-	176	-	-	-	-	-	8.8	-	-	-	-	-	-	-	-	-
042	5.42	-	-	36	-	-	-	-	-	-	-	-	45	-	-	452	-	-	-	-	-	9.0	-	-	-	-	-	-	-	-	-
050	0.37	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
053	0.52	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
074	17.15	-	-	1013	-	-	-	-	-	3575	-	-	1001	-	-	-	-	-	572	-	-	57.2	-	-	-	-	-	-	-	-	-
075	1.34	-	-	6	-	-	-	-	-	45	-	-	11	-	-	1030	-	-	213	-	-	-	-	-	-	-	-	-	-	-	-
076	6.51	-	-	-	-	-	-	-	-	163	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
079	4.13	-	-	13	-	-	-	-	-	241	-	-	34	-	-	206	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
080	2.73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
091	3.45	9707	9701	6420	-	-	-	-	-	63101	-	-	5472		766720	871315	-	8861	1757	-	187	210	-	49	144	-	287	0.3	-	-	-
Dunel Plant (to 072)	0.72	-	-	207	-	-	-	-	-	114	-	-	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Subtotal		-	-	9873	-	-	-	-	-	73118	-	-	7670	-	-	879737	-	-	4977	-	-	376.6	-	-	144	-	-	1.0	-	-	-
WWTP Influent		-	-	59130	-	-	-	-	-	187440	-	-	31930	-	-	85148	-	-	19217	-	-	4612	-	-	2720	-	-	-	-	-	4890
WWTP Mun. Influent		-	-	4823	-	-	-	-	-	9282			1824	-	-	13980	-	-	4965	-	-	527	-	-	263	-	-	-	-	-	-
Total WWTP Influent		-	-	63953	-	-	-	-	-	196722	-	-	33754	-	-	99128	-	-	24182	-	-	5139	-	-	2983	-	-	-	-	-	-
WWTP Effluent		-	-	3970	-	-	10800	-	-	45800	-	-	12700	-	-	177850	-	-	13500	-	-	3020	-	-	1500	-	-	-	-	-	3020
Total Disch. UCC + Mun.	9.52	-	-	13843	-	-	-	-	-	118918	-	-	20370	-	-	1057587	-	-	18477	-	-	3397	-	-	1644	-	-	-	-	-	7870
1971 Report to State - Av.																															

Comparison of Survey Results with Union Carbide Reports to The State

Figure 4 is based on the data Union Carbide reports monthly to the State. The survey results (Table 6) show a total of 13,843 pounds per day BOD_5 discharged to the river as compared with an average BOD_5 discharge of about 21,000 pounds per day for the last half of 1971 or 26,000 pounds per day average for all of 1971. As mentioned earlier in this report, the load to the river has been decreasing due to improving waste treatment efficiency, other abatement efforts by the company, and the shutdown of production facilities in several areas. Additional reductions would be expected for 1972 and the indicated trend is supported by the data of the survey.

Discussion of Differences in Analytical Data

BOD_5 analyses were made on composites of cooling water outfalls by the state and company; thus, comparisons on an individual outfall basis cannot be made except for Sample Point No. 26, Ward Hollow. Here the NFIC-Cincinnati BOD_5 value of 224 mg/l is significantly lower than the State figure of 338 mg/l and the Union Carbide value of 339 mg/l. Both the State and company used an adapted seed for the determination, but NFIC-Cincinnati used downstream Kanawha River water for seeding. The BOD_5 values for the cooling waters, however, appear to be reasonably close as indicated by total load calculations

NFIC-Cincinnati on an individual outfall basis, State and Company on composited outfalls).

Parameters with notable differences in the calculated loads seen in Table 5 are summarized below:

	Concentration, mg/l		
	CFIC	Union Carbide	State
Sample Point 20 - Raw River Water			
BOD_5	1.20	1.6	0.8
Tot. Solids	146.		111.
Suspended Solids	21.		16.
Nitrate and Nitrite	0.9		0.48
Sample Point 26 - Ward Hollow			
BOD_5	224.	339.	338.
Suspended Solids	82.		324.
NH_3-N	5.5		1.8
Oil and Grease	11.		1.
Phenols	.01		10.
Cadmium	.09		.004
Nickel	.05		0.4

The evlauation of the Union Carbide South Charleston Plant would not be affected significantly by the differences in values.

Toxicity of Effluents

Static bioassays were conducted on fathead minnows using wastewater discharged from the South Charleston Waste Treatment Plant and two selected untreated discharges to the river.

The Waste Treatment Plant bioassay was conducted in a dissolved oxygen range of 4.8 to 7.2 mg/l, pH of 6.7 to 6.9, and temperature of 23 to 27°C. The TL_m (median tolerance limit) was

34 percent at 24 hours, 30 percent at 48 hours, and 26 percent at 96 hours. The indicated toxicity for this nominal 10 mgd discharge is higher than would be expected of a treated effluent.

The TL_m or median tolerance limit is the concentration of effluent that would be lethal to 50 percent of the fish held in it for the specified time period, i.e., 24, 48, or 96 hours. Thus, the lower the TL_m, the higher the toxicity of the effluent.

The two highest flow untreated wastewater discharges, 17,83 mgd Outfall No. 025 (Vinyl Resins and Plasticizers Area) and 17.15 mgd Outfall No. 074 (Miscellaneous Chemicals) were checked for toxicity by means of static bioassays. Test conditions were in the dissolved oxygen range of 4.9 to 6.8 mg/l, pH 3.3 to 6.0, and temperature of 23 to 27°C. The TL_m was 14 percent at 24 hours, 10 percent at 48 hours, and 9.2 percent at 96 hours for Outfall No. 025. These TL_m's are low enough to be of concern, particularly when the flow of over 17 mgd is considered. Death of the test animals was immediate in a 100 percent discharge solution.

There was less than 50 percent mortality in 100 percent wastewater shown in the 24 hour exploratory bioassay of the 17.15 mgd wastewater stream from the Miscellaneous Chemicals Area, Outfall No. 074. Further bioassays are undertaken only when a higher than 50 percent mortality in undiluted effluent is evident.

It should be noted that only 29 percent of the total untreated wastewater flow from the Union Carbide South Charleston Plant has been checked for toxicity in this study. Thus any toxic characteristics of over 70 percent of the untreated wastewater flow have not been investigated.

Anomalies

There were no known irregularities in the analytical and operating conditions under the survey other than the previously mentioned in the BOD_5 seed materials used by Union Carbide, NFIC-Cincinnati, and the State.

CONCLUSIONS

1. Pollution abatement programs at the Union Carbide South Charleston Plant have been largely successful and have markedly reduced their pollutional loads to the Kanawha River.
2. To meet established future use criteria for the Kanawha River, significant additional improvements will be required in waste treatment and other abatement efforts at the plant.
3. The waste water treatment facilities have been operated with good efficiency in the past but a need for higher sustained efficiency is evident. Better biological treatment, nutrient control, and suspended solids removal and

minimizing the effects of peaks in organic loadings are areas for improvement.

4. The largest sources of pollutional loads to the Kanawha at the time of the survey were the Ward Hollow stream, at 6,420 pounds per day BOD_5, the Waste Treatment Plant effluent at 3,970 pounds per day, and the so-called cooling waters which total 3,453 pounds per day. The Ward Hollow stream was recently routed to the waste treatment plant. Thus, future abatement efforts must be directed toward the waste treatment plant and the untreated cooling water sources.

5. A number of the South Charleston Plant outfalls are properly classified as cooling water streams on the basis of the analytical results of this study.

6. A reduction in the time lag for the detection (in cooling waters) and correction of spills or similar upsets is desirable. Daily analyses of composite samples from each cooling water discharge now provide for routine checks.

7. The flume replacement scheduled for completion by late 1973 will bring a needed reduction in discharge of untreated industrial wastewater caused by flooding conditions in the river. Discharges will still occur during

certain flood conditions, however, and additional information for appraisal of the problem is needed.

8. Toxicity requiring abatement was detected in three of four outfalls selected for bioassay checks. The possibility of toxicity in other untested discharges exists.

RECOMMENDATIONS

General

1. It is recommended that the following discharge limits for the combined total Union Carbide-South Charleston Waste Treatment Plant be achieved by December 31, 1975:

BOD_5	3,500 pounds per day
TKN	1,950 pounds per day

These numbers are based on the approved future use criteria of 4.0 mg/l DO (25°C) and a seven day once-in-ten-years low flow of 1,930 cfs.

2. Toxicity of effluents should be reduced at least to the point that no discharge, undiluted, exceeds the 96-hour TL_m. This means that at least 50 percent of the test animals shall survive a 96-hour bioassay test in the undiluted effluent.

3. A study to characterize and pinpoint the long-term BOD or refractory organics in the wastewater streams is

recommended. This will facilitate identification and determination of removal methods.

South Charleston Waste Treatment Works

1. It is recommended that the nutrient content in the activated sludge be monitored and controlled to maintain a nitrogen content of seven percent and a phosphorus content of 1.2 percent of the volatile suspended solids. Monitoring of the wastewater for nutrient control should continue so that a ratio of 100:5:1 (BOD_5 removed:nitrogen: phosphorus) can be maintained.
2. It is recommended that the addition of coagulants or other physical-chemical treatment methods be developed and applied to maintain the primary industrial effluent suspended solids concentration below 30 mg/l.
3. Tests on the feasibility of activated carbon use to reduce and smooth out organic loadings in the primary system and to improve organic removal in the secondary system are recommended.

Union Carbide-South Charleston Plant

1. Identification of the pollutants, determination of the sources, and abatement of pollution in the following untreated wastewater discharges is recommended:

Permit Program Serial No.	Process Area	Flow MGD
074	Miscellaneous Chemicals	17.15
039	Acetaldehyde	6.14
025	Vinyl Resins and Plasticizers	17.83
023	Fine Chemicals and Vinylite	13.40
032	Aldehyde and Power House	2.77

The above are listed in the recommended order of priority which was assigned on the basis of calculated pollutional loads discharged to the Kanawha River. The sum of the BOD_5 loads from these sources is approximately 2,600 pounds per day, over half the total load from the 21 cooling water discharges sampled.

2. Routing of the Dynel Tow area untreated wastewater discharge to the industrial wastewater flume, and thus to the South Charleston Waste Treatment Plant, is recommended.

3. Engineering studies are recommended to determine the best method and obtain authorization for improving the monitoring of untreated wastewater streams. The possible use of on-line total carbon analyzers programmed to selectively sample wastewaters from various sources on a timed cycle is suggested.

4. It is recommended that the Union Carbide South Charleston Plant be required to keep an accurate and detailed log of any conditions of raw wastewater discharge from the flume to the river and to report same to regulatory authorities. This requirement could be made a condition of an appropriate discharge permit.

KANAWHA RIVER
INVESTIGATION OF WATER QUALITY
AND
WATER POLLUTION CONTROL PRACTICES

C

VOLUME II

REPORTS OF INDUSTRIAL INVESTIGATIONS
ON SEVEN INDUSTRIES

C. Union Carbide Corporation
Institute Plant
Institute, West Virginia

United States Environmental Protection Agency
Office of Enforcement and General Counsel
National Field Investigations Center - Cincinnati
and
Region III - Philadelphia
July, 1973

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REPORT OF INDUSTRIAL INVESTIGATION

UNION CARBIDE CORPORATION, CHEMICALS AND PLASTICS DIVISION

INSTITUTE, WEST VIRGINIA

GENERAL PLANT DESCRIPTION

The Union Carbide Institute plant is located on the Kanawha River at Institute, West Virginia, about six miles downstream from Charleston at River Milepoint 48.9. It lies entirely on the right side of the river (facing downstream) and occupies just over one mile of shoreline in two stretches, one of which fronts the chemical plant and the other fronting the wastewater treatment plant. The two areas are separated along the shore by about 0.5 mile occupied by a concrete supply company. Figure 1 shows the general plant layout.

The Institute plant is bounded on the southeast (upstream) by the West Virginia State College and on the northwest (downstream) and northeast sides by largely undeveloped land. The company owns 775 acres, 550 acres of which have been developed.

The Institute plant was originally built for the United States Government for World War II era production of butadiene and styrene, materials needed for the production of Buna-S rubber. In April, 1943, styrene production began and the entire plant was practically complete and in full production.

C-2

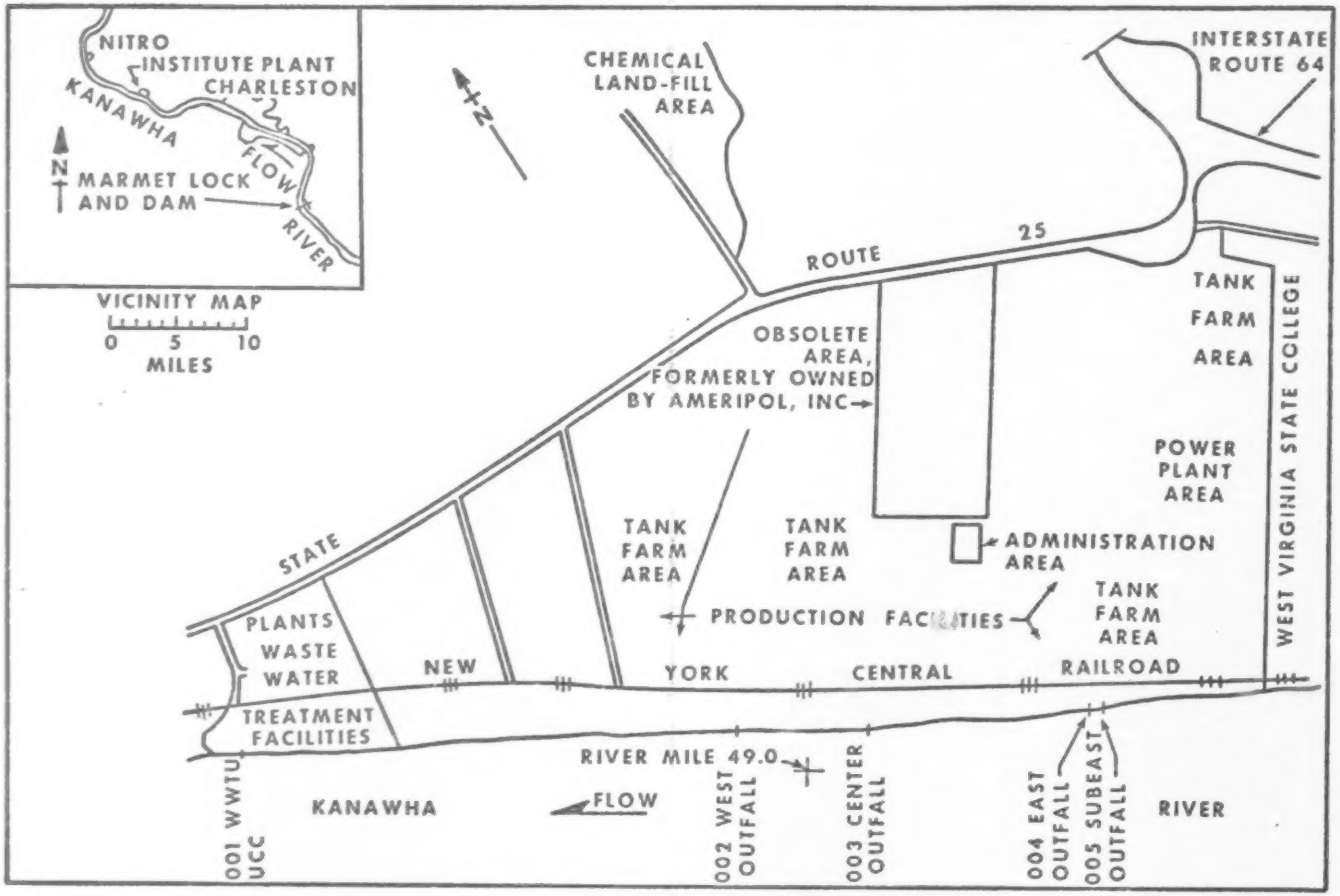

NITRO
INSTITUTE PLANT
CHARLESTON
KANAWHA
FLOW
N
MARMET LOCK AND DAM
RIVER
VICINITY MAP
0 5 10
MILES
N
CHEMICAL LAND-FILL AREA
INTERSTATE ROUTE 64
ROUTE 25
STATE
TANK FARM AREA
OBSOLETE AREA, FORMERLY OWNED BY AMERIPOL, INC
POWER PLANT AREA
WEST VIRGINIA STATE COLLEGE
TANK FARM AREA
TANK FARM AREA
ADMINISTRATION AREA
TANK FARM AREA
PRODUCTION FACILITIES
PLANTS WASTE WATER TREATMENT FACILITIES
NEW YORK CENTRAL RAILROAD
RIVER MILE 49.0
KANAWHA
FLOW
RIVER
001 WWTU UCC
002 WEST OUTFALL
003 CENTER OUTFALL
004 EAST OUTFALL
005 SUBEAST OUTFALL

FIGURE 1
UNION CARBIDE CORPORATION
INSTITUTE PLANT
GENERAL PLAN - PLANT FACILITIES
JULY 1972

In 1947, Union Carbide purchased the plant from the Government, not for the purpose of producing butadiene but with the idea of converting the facilities to produce other chemicals, such as acetone and butanol. The plant started operation of its own gas-producing facilities in December, 1950. Other additions followed. Some of these included the SEVIN complex, the fluorocarbons, and CELLOSIZE units, and an additional steam and power plant, a laboratory expansion, and several expansions and additions to production facilities.

In early 1970, Union Carbide acquired the West Virginia properties of Ameripol, Inc., a subsidiary of the B. F. Goodrich Company. The principal property consisted of a 36.2-acre parcel of land, including buildings and storage facilities, surrounded on three sides by the Institute Plant.

From an initial staff of 147 employees, the plant employment rose to almost 3,000. With recent cut-backs and some loss of production, the current level is some 1,900 employees. The plant operates 24 hours per day, 365 days per year.

The annual production of the Institute plant is about 1.5 million tons. The products are basic and intermediate materials. Among their products are chemical additives for 1) gasoline (to help prevent the stalling of automobiles); 2) jet fuels (to help prevent engine flameout); 3) popular waterbased paints (latexes); and 4) cheese, baked goods, and other foods (preservatives). Over 100 chemicals are made for the textile industry alone as basic ingredients from which many textiles are spun; and others are used to impart finishes that make clothes wear better and resist soiling, wrinkling, and shrinking. Over 90 chemicals are produced by Union Carbide for making antibiotics, vitamins, and other pharmaceuticals. SEVIN insecticide, one of several agricultural chemicals produced by Union Carbide, is being used increasingly all over the world. Table 1 lists current products of the Institute plant and their general uses, and Table 2 lists the production and/or process areas and the materials produced in each.

The principal raw material used by the Institute Plant has been natural gas. With the closing of the olefins units in mid-1972, the plant will import ethylene and propylene. Other major raw materials include chlorine and caustic, naphthalene isopropanol, ethanol, ammonia, and air.

WATER USAGE

The Union Carbide Institute plant purchases an average of 1.7 mgd of water from the Nitro municipal system and withdraws an average of 300 mgd from the Kanawha River. The latter varies seasonally and ranges from 240 mgd in winter to 350 mgd in summer.

TABLE 1

PRODUCTS MANUFACTURED AT THE UNION CARBIDE INSTITUTE PLANT

Products	Uses	UCC Brand Name
Aldehydes	Intermediates for acids, alcohols, amines	
Ketones	Solvents for lacquers, pharmaceuticals	
Alcohols	Solvents; intermediates for aldehydes, ketones	
Glycols	Solvents; automobile anti-freeze	PRESTONE
Phthalate esters	Plasticizers	FLEXOL
Alkylbenzene	Soft detergents	UCANE
Ethylene oxide adducts	Detergents, surfactants	TERGITOL
Anhydride	Intermediates	
Fluorocarbons	Propellants for aerosols, refrigerants	UCON
Polyethylene glycol	Pharmaceuticals, cosmetics	CARBOWAX
Esters	Solvents	
Acrylates	Plastics	
Polyols	Urethane foams for upholstery mattresses	NIAX
Ethylene oxide polymers	Water thickener, water soluble extruded and molded shapes	POLYOX
Isocyanates	Rigid foams	NIAX
Polymers	Oil additives	UCAR
Fibers	Synthetic yarn	
Hydroxyethyl cellulose	Paint thickener	CELLOSIZE
Glutaraldehyde	Tanning agent for leather, makes leather washable	UCAR
Mixed oxide adducts	Brake fluids, lubricants	UCON
Aryls	Intermediates, dye carriers	
Ethers	Extractants	
Pyridines	Pharmaceutical intermediates	
Oxides	Sterilizers, fumigents, intermediates	
Carbamates	Insecticides, pesticides	SEVIN

TABLE 2

PRODUCTION UNITS AND ASSOCIATED PRODUCTS

Union Carbide - Institute Plant

Units	Product or Use
Olefins[1]	Ethylene, propylene, acetylene, butadiene, dripolene - from natural gas
High pressure hydrogenation	Intermediate for weather resistant rubber
Alkylbenzene	Intermediate for biodegradable detergents
Ketones	Isopropanol, miscellaneous ketones
Misc. recovery	Miscellaneous chemicals processing
Butanol	Butanol and intermediates for other alcohols
UCAR improvers	Oil additives
CELLOSIZE	Hydroxyethyl cellulose
Catalyst	Miscellaneous catalyst
Plasticizers	Phthalate esters - plasticizers
Ethylene oxidation	Pyridines pharmaceutical intermediates
Ethylene glycol[2]	Ethylene oxide, ethylene glycol
Air separation	Nitrogen, oxygen
Acrolein derivatives	Acrolein derivatives, glutaraldehyde
Fluorocarbons	Fluorocarbons
SEVIN	SEVIN insecticide
SPANDEX	SPANDEX - yarn for elastic wearing apparel
POLYOX[3]	POLYOX
Oxide derivatives[4]	TERGITOL, TEMIK, CARBOWAX, acrylates
Rigid polyols	Polyalcohols for urethane foams
Isocyanates	TDI- foam insulation ingredient
DNT	DNT - an intermediate
Phthalic anhydride	Phthalic anhydride, FLEXOL DOP

1 - The operation of the Olefins Unit discontinued in 1972.

2 - The production of ethylene oxide discontinued in 1972.

3 - The POLYOX Unit is operated a maximum of six months per year.

4 - The production of TEMIK discontinued in 1972.

The average water usage within the plant is as follows:

Cooling Water	288.0 mgd
Process Water	5.6 mgd
Sanitary System	1.7 mgd
Other	0.7 mgd
Fly Ash Disposal	2.9 mgd
Evaporation	0.4 mgd

The plant processes about 6.0 mgd through its two in-house raw water treatment plants complete with Zeolite exchange. Purchased city water (Nitro) is used for in-plant domestic purposes and some process uses.

Cooling water usage has been reduced about 47 percent in the past ten years and was further reduced with the shutdown of the olefins complex. Other water usage has not changed materially in recent years. An average of 5.6 mgd of wastewater, including process and sanitary wastes, is treated at the company's wastewater treatment return to the Kanawha River.

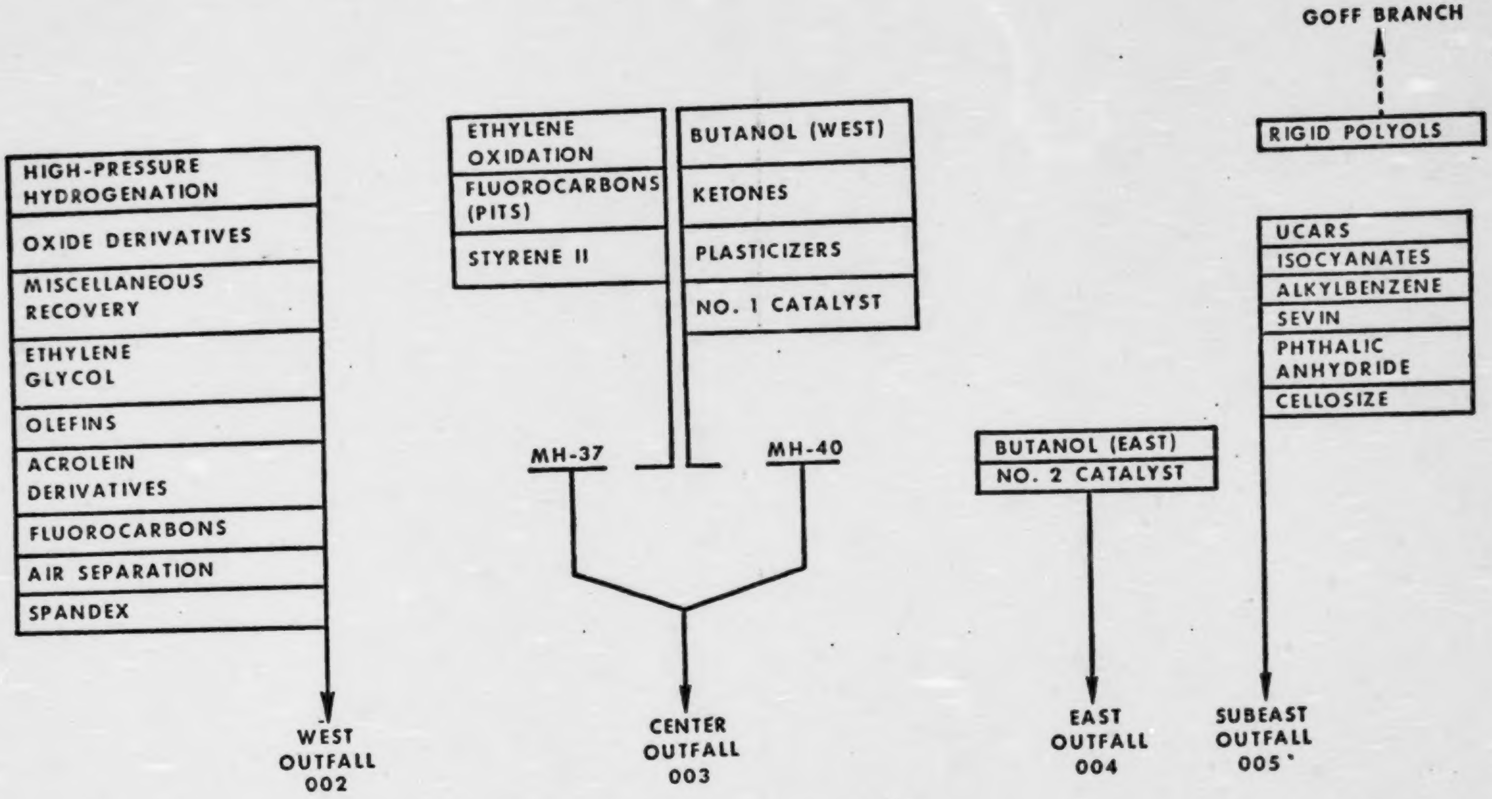
WASTEWATER DISCHARGES AND WASTE SOURCES

The Union Carbide Institute Plant has five major discharges to the Kanawha River, one of which is the waste treatment plant outfall, and four of which are cooling water outfalls. The plant also discharges wastes to Goff Branch, a small stream bordering the plant on the southeast, which drains into the Kanawha. Figure 2 is a flow diagram showing the cooling water unit sources and Figure 3 is a flow diagram showing the unit sources of wastewaters directed to the wastewater treatment plant.

The waste treatment outfall (001) is submerged and usually creates a surface boil in the river. Three cooling water outfalls (002, 003, 004) are above water, while the fourth (005) is submerged and also creates a surface boil.

While discharging primarily cooling waters, outfalls 002, 003, 004, and 005 contain significant quantiities of pollutants. The company claims to have separated as much as possible all direct continuous and intermittent process discharges to the cooling water sewers. The complexity of process operations and the thousands of pumps, valves, and pipes utilized in the water system results in a constant contamination of the cooling water.

Direct discharges to the river occur from traveling screen backwashes at the three raw water intake pumphouses. Some accidental discharges from production areas and a hydrochloric acid neutralization process into Goff Branch have occurred in the past.


GOFF BRANCH
RIGID POLYOLS
HIGH-PRESSURE HYDROGENATION
OXIDE DERIVATIVES
MISCELLANEOUS RECOVERY
ETHYLENE GLYCOL
OLEFINS
ACROLEIN DERIVATIVES
FLUOROCARBONS
AIR SEPARATION
SPANDEX
ETHYLENE OXIDATION
FLUOROCARBONS (PITS)
STYRENE II
BUTANOL (WEST)
KETONES
PLASTICIZERS
NO. 1 CATALYST
MH-37
MH-40
BUTANOL (EAST)
NO. 2 CATALYST
UCARS
ISOCYANATES
ALKYLBENZENE
SEVIN
PHTHALIC ANHYDRIDE
CELLOSIZE
WEST OUTFALL 002
CENTER OUTFALL 003
EAST OUTFALL 004
SUBEAST OUTFALL 005¹

NOTE:
1. DNT Unit has recycle cooling water system.

FIGURE 2
COOLING WATER UNIT SOURCES
UNION CARBIDE CORPORATION
INSTITUTE PLANT
INSTITUTE, WEST VIRGINIA

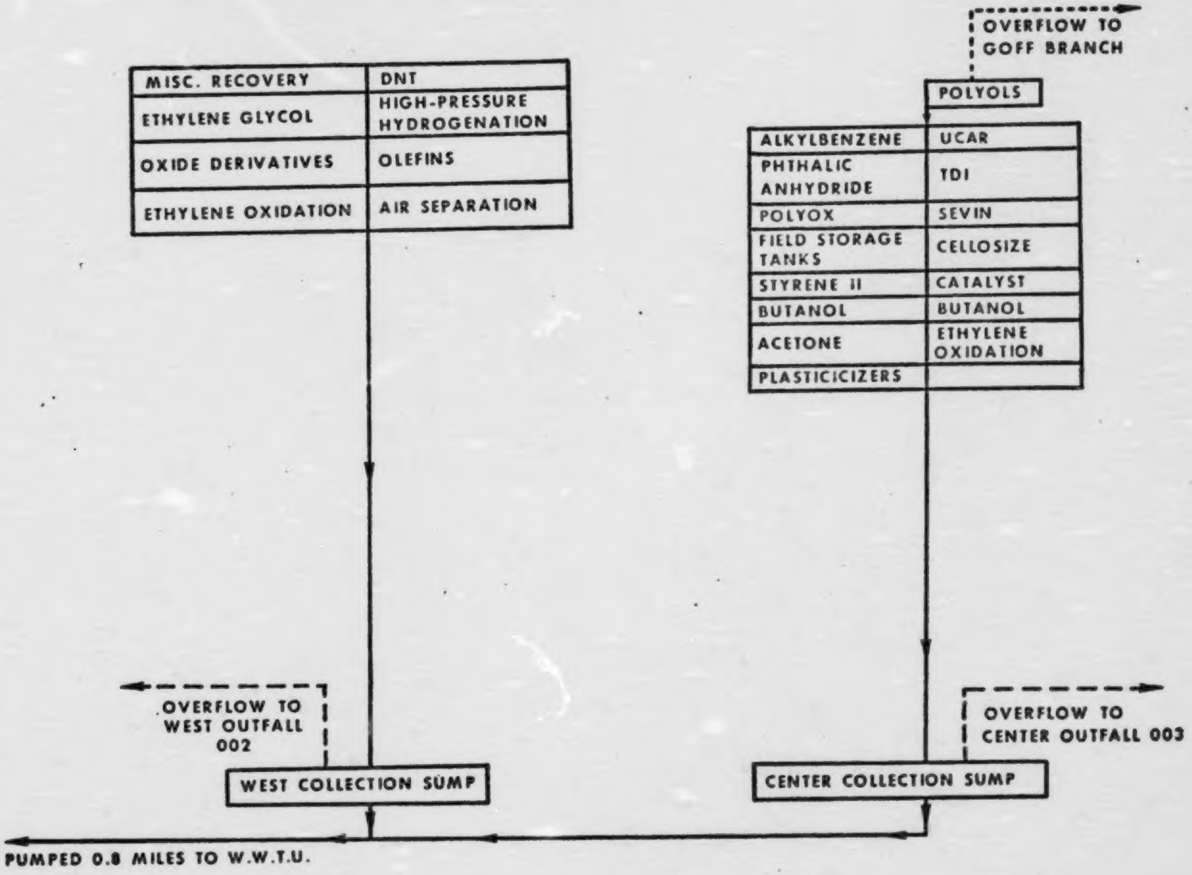

MISC. RECOVERY
DNT
ETHYLENE GLYCOL
HIGH-PRESSURE HYDROGENATION
OXIDE DERIVATIVES
OLEFINS
ETHYLENE OXIDATION
AIR SEPARATION
OVERFLOW TO GOFF BRANCH
POLYOLS
ALKYLBENZENE
UCAR
PHTHALIC ANHYDRIDE
TDI
POLYOX
SEVIN
FIELD STORAGE TANKS
CELLOSIZE
STYRENE II
CATALYST
BUTANOL
BUTANOL
ACETONE
ETHYLENE OXIDATION
PLASTICICIZERS
OVERFLOW TO WEST OUTFALL 002
WEST COLLECTION SUMP
OVERFLOW TO CENTER OUTFALL 003
CENTER COLLECTION SUMP
PUMPED 0.8 MILES TO W.W.T.U.

FIGURE 3

UNIT SOURCES OF WASTEWATERS DIRECTED TO THE WASTEWATER TREATMENT PLANT
UNION CARBIDE CORPORATION
INSTITUTE PLANT
INSTITUTE, WEST VIRGINIA

WASTE TREATMENT PROGRAM

Historical Development

Information on waste control efforts prior to the initiation in 1958 of the state phased program has not been obtained from the company. At the beginning of the phased cleanup program in 1958 the Union Carbide Institute plant was apportioned about 130,000 pounds per day BOD_5 as its average contribution to the Kanawha River. Figure 4 is a company graph of raw BOD_5 loads, permit limits, and load discharged since the inception of the phased program to 1971. Since the inception of the phased program thirty to forty percent of the BOD_5 load to the river has been via cooling water.

Phase I

The Phase I program required a forty percent reduction of the 1958 BOD_5 base load by mid-1963. Allowable discharge would be 78,000 pounds per day BOD_5.

The company constructed an aerated stabilization facility with a BOD_5 removal capacity of 50,000 pounds per day as the final step in meeting the Phase I requirements. This facility came on line in 1963. Preliminary work to reduce to a minimum the wastes to be biologically treated included source eliminations, tighter housekeeping and powerhouse incineration.

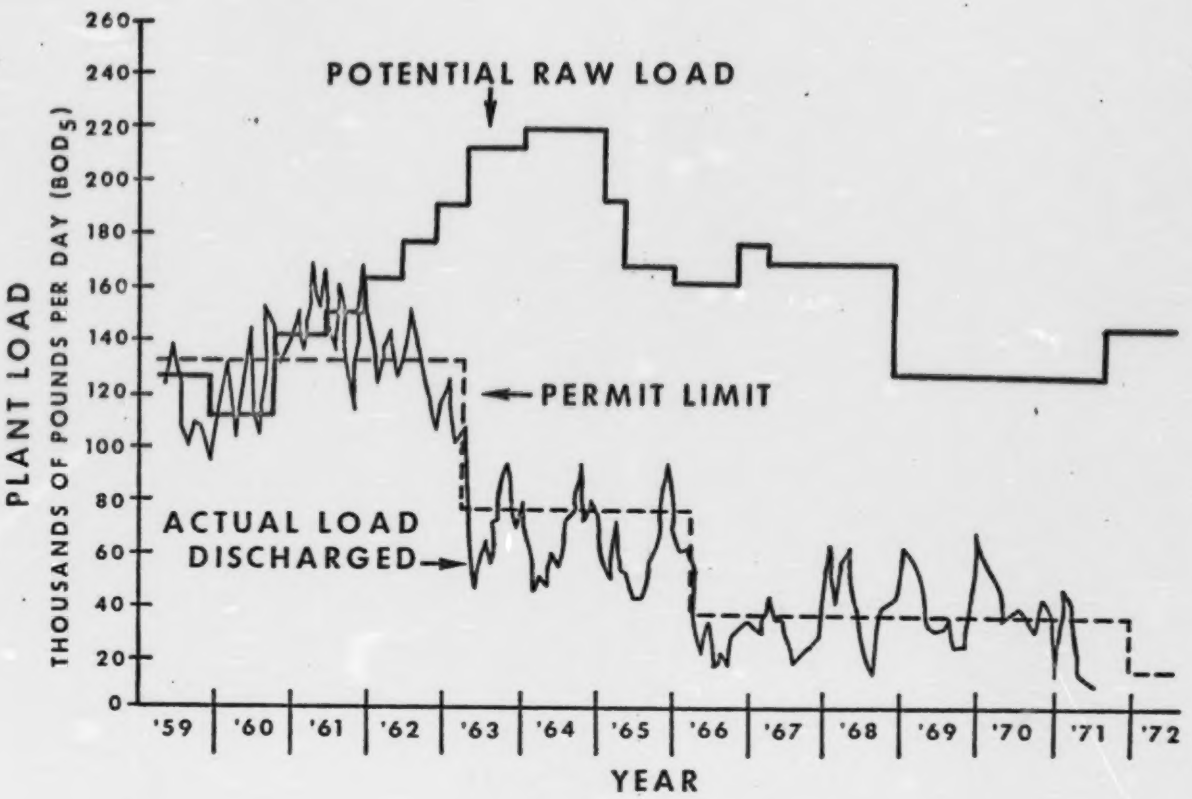


FIGURE 4
RAWLOAD, PERMIT LIMITS, AND LOAD DISCHARGED
UNION CARBIDE CORPORATION
INSTITUTE PLANT
INSTITUTE, WEST VIRGINIA

Phase II

Since Phase I completion did not result in the river meeting the water quality objectives, Phase II was established which required the Institute plant to achieve a 70 percent reduction of the 1958 load by mid-1966. This step would allow a 39,000 pounds per day BOD_5 discharge. This limit was attained by expanding the aerated lagoon to an activated sludge system, improving in source controls and installing elaborate in-plant monitoring and control system. These improvements were completed in 1966.

Phase III

Because the Phase II program still did not achieve a minimum of 3.0 mg/l DO in the Kanawha River at the sag point, the state initiated a Phase III program in 1969. For the Institute plant, the requirement was for an 85 percent reduction in the BOD_5 1958 load and as large a reduction of nitrogenous load as practical by the end of 1972. The allowable BOD_5 discharge was reduced to 19,500 pounds per day.

To obtain the Phase III reductions, six additional 100 horsepower aerators were installed. This increased the BOD_5 reduction capacity of the biological system to about 97,000 pounds per day BOD_5. Source control measures included the installation of stripping stills, decanters, and incineration. Additional low flow waste streams were diverted from the cooling water to the

Waste Treatment Unit. Production unit shutdowns also resulted in decreasing waste discharge loadings. A 65 percent reduction in the oxidizable nitrogen load and a reduction of 15,000 pounds per day reduction in BOD_5 to the biological system was the result of the retirement of the Acrylic Esters Unit.

The company indicated that improvement in operation of the final clarifiers and removal of TERGITOL detergents have resulted in a 75 percent reduction of suspended solids, a decrease of 6,000 pounds per day BOD_5 discharge to the river from the wastewater treatment plant. Expansion of the cooling water monitoring system and installation of carbon analyzers on the major outfalls has minimized the duration of accidental spills, condenser leaks, etc. The company's records indicate that the Phase III BOD_5 goal was attained during eight months of 1971.

Existing Waste Treatment Facilities

Incineration and Landfill

One of two powerhouses is modified to allow burning of liquid organic wastes. For 1971, the average equivalent BOD_5 burned amounted to 600,000 pounds per day. Heat value is obtained from this process, but about 90,000 pounds per day is such a dilute solution that heat benefit is minimal.

An average of 2.9 mgd of fly ash slurry is handled by a private contractor, the Cunningham Realty Company, and pumped to a landfill site about 1.5 miles east of the Institute plant. The overflow from the site discharges to Finney Creek, which in turn discharges to the Kanawha River. This fly ash disposal operation is further described in Volume III of this report under the Cunningham Realty Company.

The Union Carbide Institute plant's Environmental Department operates a state-licensed chemical landfill (Goff Mountain Landfill) on a 40 acre mountain valley site just north of the plant area. At present about seven acres are being utilized. According to the company, the Institute plant is the first and only industrial plant in the United States that intentionally disposes of organic chemicals in a licensed scientific landfill. At the Goff Mountain Landfill, solid organic chemical wastes consisting of filter cakes, rejected products, etc., are handled by programming them into a carefully managed disposal pattern. The solid materials are retained by a leaky earth dam. Liquid run-off is directed through the dam and collected. The collected run-off receives treatment through the wastewater treatment plant.

In addition to Goff Mountain Landfill and the fly ash disposal site, a 15 acre site west of the wastewater treatment plant is used for inert (non-chemical) material disposal.

Wastewater Disposal

Wastewater Treatment Plant

All process waterborne wastes and other wastes such as sanitary, drainage from tank truck loading racks, Goff Mountain Landfill drainage, etc., are treated at the wastewater treatment plant. The current BOD_5 loading to the plant averages about 110,000 pounds per day. The loading may vary considerably from this principally because wastes from the CELLOSIZE unit may be either burned or routed to the treatment plant depending upon varying conditions.

The wastewater treatment plant is situated approximately 0.8 mile downstream from the production site. It occupies a 15 acre site with room for expansion.

The wastewater treatment facilities include three specific systems as described below:

1. The collection and pumping system - Process wastes from the plant are collected in two sump areas (see Figure 3). The Center Sump collects the east and west plant area wastes while the West Sump collects the western plant area wastes. It is the usual practice for the control room at the treatment plant to monitor the incoming pH to the sumps and to manipulate it by requesting deliberate additions of acid or base from various production units.

The wastes are transferred approximately one mile to the wastewater treatment plant via a 20-inch diameter polyester, fiberglass-reinforced pipe.

2. Primary System - Equalization Basin (see Figure 5) Wastewater from the transfer line first enters a one million gallon equalization basin designed to minimize the effects of varying discharges of organic, acidic, and basic wastes. The basin has a 4-hour retention time at the normal waste flow of 5.6 mgd. Primary settling occurs and the resulting sludge is transferred to the adjacent sludge storage basin. Floating organic chemicals and solids are also removed by mechanical means. Automated measurements of flow, pH, temperature, total carbon and specific organic chemicals, are recorded for the effluent from the equalization basin (the influent to the aeration basins.)

3. Secondary System - Biological Aeration Basins (See Figure 5). The secondary system consists of three 5 million gallon, one-acre aeration basins containing a total of fifteen 75 horsepower and fifteen 100 horsepower aerators, and two 316,000 gallon final clarifiers.

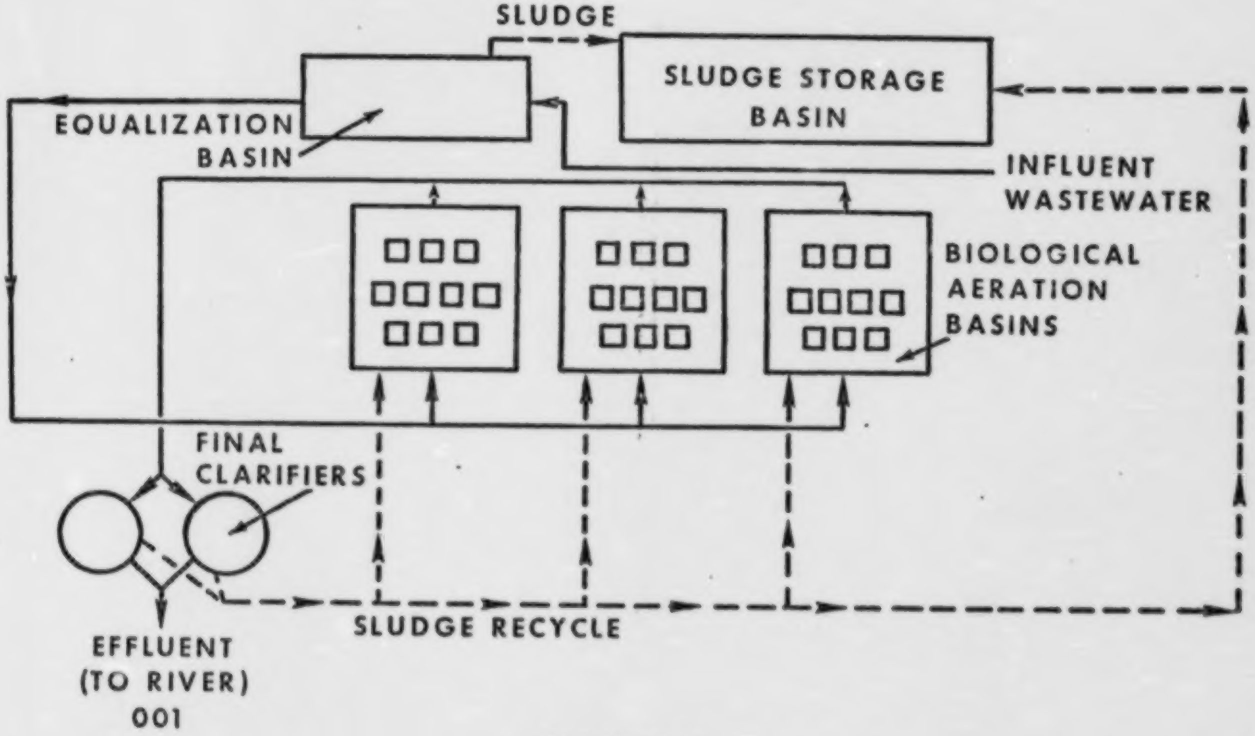

SLUDGE
SLUDGE STORAGE BASIN
EQUALIZATION BASIN
INFLUENT WASTEWATER
BIOLOGICAL AERATION BASINS
FINAL CLARIFIERS
SLUDGE RECYCLE
EFFLUENT (TO RIVER) 001

FIGURE 5
INSTITUTE PLANT'S WASTE WATER TREATMENT UNIT
UNION CARBIDE CORPORATION
INSTITUTE PLANT
INSTITUTE, WEST VIRGINIA

When operating without any recycle, the aeration basins have a retention time of 62 hours and the final clarifiers 2.5 hours at the average plant wastewater flow of 5.6 mgd. With wastewater flow plus the normal return sludge flow, the aeration basin retention time is reduced to 40 hours. The three aeration basins have been designed so they can be operated in parallel or in series.

The effluent of the aeration basins is transported to the two final clarifiers. The liquid over flow from the two final clarifiers is discharged to the river through the submerged outfall No. 001. Two sludge pumps move the settled materials from the bottom of the clarifiers for recycling to the aeration basin or wasting to the twelve million gallon sludge holding basin. Sludge from the holding basin is pumped to sludge drying beds adjacent to the basin.

Cooling Water

The water requirement for cooling is 275 mgd summertime demand and a winter requirement of 238 mgd. The summer average discharge quantity of cooling water for each outfall is:

Description	Discharge of Cooling Water
001 WWTU	-- MGD
002 West Outfall	90 MGD
003 Center Outfall	105 MGD
004 East Outfall	15 MGD
005 Sub East Outfall	65 MGD
	275 MGD

Monitoring

The "Institute Plant" has an extensive monitoring program which includes in-plant process waters, cooling waters, river water, outfalls, and wastewater treatment unit evaluations. The present sewer sampling schedule for the plant is illustrated in Table 3, and the on-stream analyzers or monitors are defined in Table 4. A total of 26 in-plant process waste water samplers, and 43 cooling water samplers are utilized on a daily basis.

TABLE 3

SEWER SAMPLING SCHEDULE

Union Carbide Corporation - Institute Plant
Chemicals and Plastics Environmental Protection Dept.

	Inlet Water No. 2 Pumphouse	River Water St. Albans Bridge	WWTU Influent	Center Collection Sump	West Collection Sump	WWTU Effluent	Cooling Water Composite	Cooling Water West Outfall	Cooling Water Center Outfall MH-40 Branch	Cooling Water Center Outfall MH-37 Branch	Cooling Water East Outfall	Cooling Water Subeast Outfall	Goff Branch	Contractors Flyash Pond Effluent	Unit Process Sewers 26 Samples Max.	Unit Cooling Water Sewers 43 Samples Max.	Each of 3 Biobasins
Dissolved Oxygen	-	-	-	-	-	-	-	-	-				-	-	-	-	3/D
Biobasin Oxygen Uptake	-	-	-	-	-	-	-	-	-				-	-	-	-	3/D
Temperature	-	2/W	-	-	-	-	-	-	-				-	-	-	-	2/D
Carbonate Carbon	5/W	-	1/W	5/W	5/W	1/W	5/W	5/W	5/W	5/W	5/W	5/W	5/W	5/W	As needed		-
Organic Carbon	5/W	-	1/D	5/W	5/W	1/D	5/W	5/W	5/W	5/W	5/W	5/W	5/W	5/W	5/W	5/W	-
BOD_5	2/W	-	2/W	-	-	2/W	2/W	-	-	-	-	-	1/W	-	-	-	-
BOD_{20}	1/W	-	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Gas Chromatography	-	-	1/W	5/W	5/W	1/W	-	5/W	5/W	5/W	5/W	5/W	-	1/W	As Requested		-
Acidity	1/W	-	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Alkalinity	1/W	-	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
COD	1/W	-	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Chlorides	1/W	2/W	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Color	1/W	-	-	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
pH	2/W	2/W	2/W	5/W	5/W	2/W	2/W	-	-	-	-	-	5/W	5/W	-	-	2/D
Ortho Phosphate	-	-	5/W	-	-	5/W	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	1/W	-	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	
Phenolics	1/W	-	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Ammonia Nitrogen	1/W	1/W	1/W	5/W	5/W	2/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Kjeldahl Nitrogen	1/W	1/W	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Nitrate Nitrogen	1/W	-	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Total Volatile Solids	1/W	-	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Suspended Solids	1/W	-	1/W	-	-	1/D	1/W	-	-	-	-	-	1/W	5/W	-	-	5/W*
Soluble Solids	1/W	-	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Fecal Coliform	1/W	-	-	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Total Coliform	1/M	-	--	-	-	1/M	1/M	-	-	-	-	-	1/M	-	-	-	-
Fecal Strep	1/M	-	-	-	-	1/M	1/M	-	-	-	-	-	1/M	-	-	-	-
Oil & Grease	1/M	-	-	-	-	1/M	1/M	-	-	-	-	-	1/M	-	-	-	-
Specific Conductivity	1/M	-	-	-	-	1/M	1/M	-	-	-	-	-	1/M	-	-	-	-
Sulfide	1/M	-	--	-	-	1/M	1/M	-	-	-	-	-	1/M	-	-	-	-
Sulfite	1/M	-	-	-	-	1/M	1/M	-	-	-	-	-	1/M	-	-	-	-
Surfactants	1/M	-	-	-	-	-	1/M	-	-	-	-	-	-	-	-	-	-
Turbidity	1/M	-	-	-	-	1/M	1/M	-	-	-	-	-	-	-	-	-	-
Sulfates	1/M	-	-	-	-	1/M	1/M	-	-	-	-	-	-	-	-	-	-
Total Hardness	1/M	-	-	-	-	1/M	1/M	-	-	-	-	-	-	-	-	-	-
Metals	1/M	-	-	-	-	1/M	1/M	-	-	-	-	-	1/M	-	-	-	-

Composite of all 3 Biobasins.

TABLE 4

ON-STREAM ANALYZERS OR MONITORS

Union Carbide Corporation - Institute Plant
Chemicals and Plastics Environmental Protection Dept.

	River Water	Cooling Water			Outfalls		Wastewater Treatment Unit			
			Center					Each of 3	Each of 2	
	No. 2 Pumphouse	West	MH-40	MH-37	East	Subeast	Influent	Biobasins	Clarifiers	Effluent
Total Carbon	X	X	X	X	X	X	X			X
Gas Chromatography			X			X	X			
Dissolved Oxygen								X		
pH							X	X		
Flow							X	X		
Solids Level									X	

Efficiency of Waste Treatment

Prior to 1963 and the completion of facilities to meet the requirements of the Phase I program the Institute plant had essentially no treatment of its waterborne waste loads. Any load reductions prior to that time resulted primarily from increased process control. Since 1963 the progress in treatment efficiency is illustrated by the reduction in BOD_5 loads to the river vs. raw waterborne BOD_5 loads as shown in Figure 6, constructed from plant data. In this graph the difference between the total raw load and the total to the river equals the removal obtained in the wastewater treatment plant.

BOD_5 removal efficiencies for the initial wastewater treatment plant (Phase I) generally ranged between 50 and 60 percent. Expansion for Phase II in 1966 resulted in an increase to 70 percent until the end of 1967. Since that time the efficiency has been widely variable, renging from a 40 percent low in December, 1969, to a high of more than 90 percent in mid-1971. The entire year of 1969 averaged about 60 percent BOD_5 removal.

Table 5 summarizes, as annual averages, the BOD_5 loading data for cooling water and the wastewater treatment unit discharges from the Institute plant since 1963. The data shows a continuous reduction in cooling water BOD_5 load until 1966, C-2A

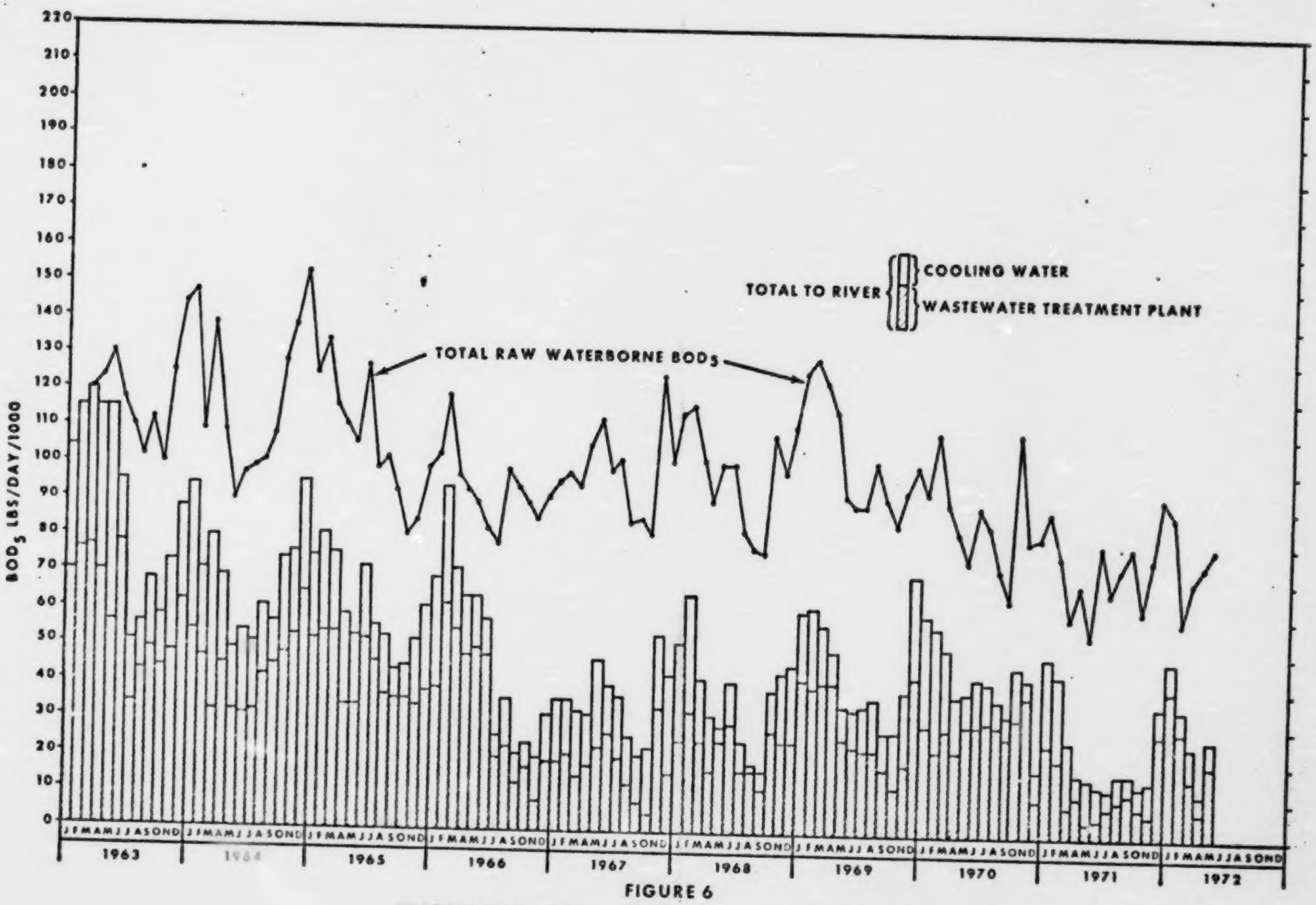


FIGURE 6
WATERBORNE BOD5 LOADS - RAW AND DISCHARGED
(PLANT DATA)
UNION CARBIDE CORPORATION, INSTITUTE PLANT
INSTITUTE, WEST VIRGINIA

TABLE 5

SUMMARY OF BOD$_5$ LOADINGS - UNION CARBIDE INSTITUTE PLANT
COOLING WATER AND TREATMENT PLANT

	Cooling Water		Treatment Plant			Total Load
	lbs/day/1000	% of load to river	Influent lbs/day/1000	Effluent lbs/day/1000	% Removal	lbs/day/1000
1963	27.6	32	87.6	58.9	33	86.5
1964	23.5	34	92.7	45.7	51	69.2
1965	19.9	33	88.1	40.7	54	60.6
1966	15.0	31	78.8	33.2	58	48.2
1967	16.2	45	82.7	19.5	77	35.7
1968	14.4	39	83.2	23.0	72	37.4
1969	14.3	32	88.7	30.4	66	44.7
1970	14.5	34	72.2	27.7	61	42.2
1971	10.8	47	63.3	12.4	80	23.2

then a leveling off until 1971, and another reduction in 1971. In 1971, the cooling water BOD_5 load averaged 39.2 percent of the 1963 load. Treatment plant influent BOD_5 loadings were erratic until 1970 when an 18.6 percent reduction occurred. The 1971 treatment plant influent BOD_5 was 72.2 percent of the 1963 load.

Waste treatment plant efficiency of BOD_5 removal increased steadily from 1963 through 1967, with a sharp rise after the plant was expanded in 1966. However, the average annual efficiency then dropped steadily for the period 1969 through 1970. In 1971, the annual efficiency returned to 80 percent, the highest level observed.

Historical information on efficiency in reduction of suspended solids is not available. However, the treatment plant effluent, according to company data, varied in annual average between 20,000 and 26,000 pounds per day for the years 1966 through 1970. Early in 1971 the average dropped to less than 10,000 pounds per day and has remained near this level. The recent reduction in this load and much of the recent reduction in BOD_5 loads can be attributed to improvements in the operation of the final clarifiers, removal of TERGITOL detergents at the source, and shutdown of the Acrylic Esters Unit.

Data on Kjeldahl nitrogen loads from the wastewater treatment plant since show wide variability from 1968 through 1970 but a decline in average load from 30,000 pounds per day in 1968 to 25,000 pounds per day in 1970. The average dropped to about 5,000 pounds per day in early 1971 and has remained there. Since the treatment plant is ineffective in nitrogen removal, the decrease has resulted from source control. The large decrease in early 1971 resulted from the closedown of the Acrylic Esters Unit.

Spill Potential

The Institute plant has an inherent design weakness in that the cold cooling water drainage system is physically positioned so that spillages drain to this system unless pumped directly to the process waste line. This situation will favor the direct discharge of most production unit upsets, pond drainage, leaky glands, etc., and spills resulting from negligence and mechanical failure.

Notable recent spills include an over-filling of a barge resulting in a loss of 46,000 gallons of methyl isobutyl ketone (MLBR) on January 20, 1972. Dicyclopentodiene was discharged through a spill into a cooling water sewer in February 15, 1972.

The potential for significant spills of chemicals at the Institute plant is relatively high based on past experience. The plant recognizes this problem and has a monitoring system to detect spills to cooling water, with plans to further improve it.

Future Plans

The Union Carbide Institute plant has plans to increase and maintain the effectiveness of the system. The company lists the following projects, some of which may have been completed by the time of this writing:

	Project	Purpose
1.	Tie east field storage tanks to process sewer.	Divert surface drainage wastes from cooling water.
2.	Install specific organic chemical analyzer on sub-east.	Rapid indentification and correction at source of spills.
3.	Signal transmission system to WWTU.	Reliability.
4.	New pump and modify two existing ones at center sump, and modify control instrumentation.	Increased reliability. Eliminate overflow to cooling water.
5.	Parallel transfer line from plant to WWTU (0.8 mile).	Insurance against break.
6.	Two new sludge recycle pumps at WWTU.	Provide reliability and increase sludge recycle capacity.
7.	WWTU Instrumentation	Reliability and control of process.
8.	A new parallel line for effluent transfer from the biobasins to the secondary clarifiers.	Prevent backup of flow in biobasins.
9.	In-plant measures at units to reduce BOD_5 to cooling water by 2,200 pounds per day.	Collect and recover or burn.
10.	Install interceptor process sewer.	Serve plant river bank - shipping dock area.

11. Install sludge drying basin. The dried sludge will be mixed with soil.	This mix will be used as the blending agent at the Goff Chemical Landfill.

NFIC-CINCINNATI FIELD SURVEY

Sampling

In order to confirm and/or ascertain the magnitude of waste constitutent discharge loadings and sources, the EPA conducted a 24-hour sampling survey of the plant intake water waste treatment plant influent and effluent, the four main cooling water outfalls, and Goff Branch on February 23 and 24, 1972. Two-hour grab samples were composited for each outfall and split with the company and the West Virginia Division of Water Resources. The analytical results, converted to pounds per day net loadings, are listed in Table 6.

Analysis

Using the company data, the treatment plant efficiency for BOD_5 removal was 55 percent during the survey. The wastewater treatment plant was in the midst of an upset at the time of sampling.

About half the BOD_5 discharged to the river came from the wastewater treatment plant effluent (001). The remainder of the five day BOD loadings resulted from cooling waters, mainly from the west and center outfalls. The company COD and TOC values were correlatable with BOD_5 during the survey. Over one million pounds per day of dissolved solids (related to chlorides) were apparent,

TABLE 6

UNION CARBIDE INSTITUTE PLANT

NET LOADS LBS/DAY

EPA SURVEY 9/23-9/24/79

	Wastewater Treatment Plant - Influent			Wastewater Treatment Plant-Effluent(001)			West Outfall (002)			Center Outfall (003)			East Outfall (004)			Subeast Outfall (005)			Goff Branch			Total to River	
	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	EPA
Flow	5.8			5.8			74.9			54.1			11.9			55.3			2.9				
BOD$_5$	45,100		86,500	85,400	88,000	73,300	9,500		9,300	7,900		8,840	2,230		3,040	484	2,170	2,170	370	430	270	50,200	40,900
BOD$_{20}$					36,600	47,700											2,350			670			
COD	107,500		106,600	93,900		87,700	23,100		0	18,900		0	4,420		2,150	11,100		14,300	0		1,350	151,500	105,500
TOC	55,900		93,300	37,000		22,800	8,740		0	7,220		900	1,680		750	3,230	0	700		990		57,900	75,100
Total Solids	37,700		770,000	338,000	337,000	337,000	57,500		37,500	718,000		109,000	5,140		6,720	458,000	349,000	385,000	17,800	17,900	17,900	1,509,000	888,000
Susp. Solids	2,610		3,530	1,980	5,760	1,890	9,990		17,500	35,600		0	3,360		1,400	54,900	57,600	52,600	9,070	9,290	8,970	114,900	82,400
Vol. Solids	42,300			53,900			31,900			69,500			190			107,000			3,120			264,900	
Chloride	201,000		203,000	187,000	200,000		0			307,000		35,200	0			151,000	144,000	153,000	2,660	3,310	3,450	642,700	
NH$_3$-N	770			850	1,900	2,270	37		0	72		0	4		0	14	100	46	4	0	14	930	2,330
TKN	2,860			3,850	3,650	3,290	510		125	580		45	110		100	280	190	140	66	17	26	5,400	3,730
NO$_3$-N	290			14	410		56			0			83			0	0		19	99		169	
NO$_2$-N	1			5			0			4			9			0			0			18	
Phenols	180		100	120	54	100	9		12	13		13	2		9	15	11	9	7	5	6	166	148
Acidity	1,710			1,210			6,250			0			0			13,800			0			21,260	
Alkalinity	86,100			18,600			9,370			2,250			0			9,270			1,450			40,900	
Oil & Grease	2,370		9,670	970		1,090	0		0	450		900	100		0	0		0	0		0	1,550	9,790
Sulfates	3,050			9,040			0			0			180			0		0	1,160			10,380	
PCB	0		0	0		0	0		6	0		0	0		0	0		50	0		0	0	96
Aluminum					500												230			100			
Arsenic					0												0			0			
Magnesium					43												1,750			840			
Manganese					1												3			7	4		
Iron					0												230			210			
Calcium					72												75,400			1,130			
Cadmium					330												0			0			
Nickel					5												0			0			
Lead					0.5												7			0			
Copper			6		12												0			0			
Zinc					14												0			2			
Sodium					198,000												39,000			4,700			
Potassium					330												0			65			
Chromium			5		5												0			0			
pH	7.1			7.6	7.5		9.8			6.8			7.8			10.4	9.9		7.9	7.2			
TO No.					1,000												50			50			

particularly from the treatment plant, the center outfall, and the sub-east outfall.

Phenol loading from the plant was over 100 pounds per day from the waste water treatment unit, and an additional forty pounds per day in cooling water discharges. Oil and grease concentrations were 38 mg/l (EPA) and 19 mg/l (Company) from the treatment unit.

Metals analyses by the State indicated effluent loadings of cadmium, aluminum, magnesium, calcium, and sodium. The cadmium loading is of particular concern with a loading of 330 pounds per day or over 6 mg/l in the biological system effluent.

Major Sources and Loads

Major organic loadings and inorganic pollutant discharges result from the wastewater treatment plant, the center outfall (003) and the sub-east outfall 005. The discharge of West outfall (002) contains high volatile solids and organic matter. The phenol load of 100 pounds per day from the treatment facilities reflects the upset condition of the biological system. Under favorable biological growth conditions the activated sludge system is capable of 99+percent efficiency.

Toxicity of Effluents

Static bioassay tests, using fathead minnows, were made in March, 1972, on three Union Carbide Institute Plant outfalls.

The outfalls tested were the waste treatment plant (001), the center outfall (003), and the sub-east outfall (005). The tests were made in a dissolved oxygen range of 4.0 to 5.8 mg/1, pH 6.6 to 6.9 and a temperature of 23 to 27°C. Toxicity was shown only in the effluent from the waste treatment plant (001). The median tolerance limit (TL_m) wastewater percentage at 24 hours was 24 percent, at 48 hours 9 percent, and at 96 hours 9 percent. All of the toxicity occurred within 48 hours. The TL_m is the percentage of wastewater by volume which will kill 50 percent of the test organisms in the specified time. The toxic agent is not known, but cadmium is suspected.

Anomalies

A serious decline in wastewater treatment efficiency occurred in the winter of 1971-72, encompassing the time of this investigation. The decline was attributed by the company to a mismanagement of pH control, effecting a kill of organisms in the aeration basins. South Charleston treatment plant sludge was used to reseed but recovery was slow, apparently due to inhibition from the chemical landfill leachate.

The analyses of the survey samples for the Institute Plant showed greater inconsistency than expected between laboratories. There appears to have been an error in the EPA wastewater treatment plant influent BOD sample, with a result much lower than would be reasonably expected. The company result is assumed more correct. There were wide inconsistencies in COD, TOC, solids, and nitrogen analyses. It is not known which are more correct. Even with the discrepancies, most values fall within the ranges reported by the company during 1971 for those parameters.

CONCLUSIONS

Union Carbide Corporation's Institute plant at Institute, West Virginia, has exhibited a concerted and conscientious effort in the area of environmental control. The in-plant monitoring , wastewater treatment unit monitoring, and effluent monitoring programs are presently as extensive and comprehensive as any in the industry. The activated sludge process and associated sludge disposal practices are currently in phase with secondary treatment requirements. Toxicity is a definite problem for the biological system which must be solved if higher treatment efficiencies are to be realized. The diversion of contaminated streams from cooling water systems which serve the plant hold the key as to the effectiveness of any future abatement program. Without additional removal of contaminants from the cooling waters, it is doubtful that the company can meet any reasonably imposed discharge criteria.

RECOMMENDATIONS

It is recommended that the Union Carbide Institute Plant:

1. Reduce the toxicity of effluents so that no discharge exceeds the 96 hour TL_m.
2. Maintain effluent constantly within a pH range of 6.0 to 8.5.
3. Separate and treat waste streams from cooling waters which presently add BOD, COD, TOC, phenols, suspended solids, oil and grease.
4. Reduce the total phenol discharges to the state - imposed limit of four pounds per day.
5. Reduce the total BOD_5 discharge to the river to a total of no more than 2,800 pounds per day in order for the Kanawha River to meet the DO criteria of 4.0 mg/l at the existing seven-day, once-in-ten-year low flow.
6. Reduce to an absolute minimum via process control and recycling the load of dissolved solids discharged to the river.
7. Reduce the spill potential of organic chemicals to the cooling water by transferring that potential wherever possible to the process sewer system.
8. Take steps to improve treatment at its wastewater treatment plant to maintain BOD_5 and suspended solids reduction at 90 percent or greater.

KANAWHA RIVER
INVESTIGATION OF WATER QUALITY
AND
WATER POLLUTION CONTROL PRACTICES

VOLUME II

D

REPORTS OF INDUSTRIAL INVESTIGATIONS
ON SEVEN INDUSTRIES

D. FMC Corporation
Inorganic Chemicals Division
South Charleston, West Virginia

United States Environmental Protection Agency
Office of Enforcement and General Counsel
National Field Investigations Center - Cincinnati
and
Region III - Philadelphia
July, 1973

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REPORT OF INDUSTRIAL INVESTIGATION

FMC CORPORATION, INORGANIC CHEMICALS DIVISION

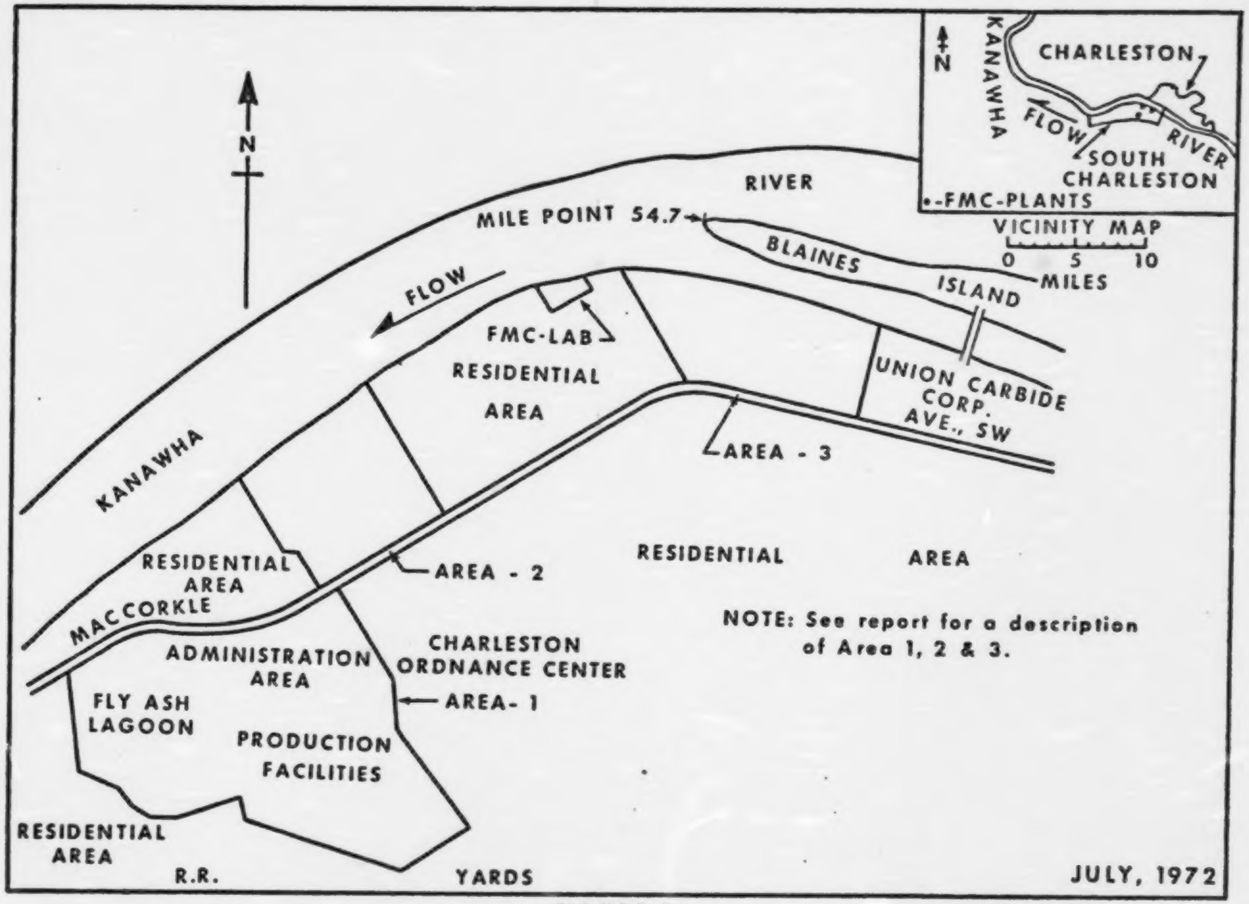
SOUTH CHARLESTON, WEST VIRGINIA

GENERAL PLANT DESCRIPTION

The FMC Inorganic Chemicals Division Plant is located in South Charleston, West Virginia, lying entirely on the left bank (facing downstream) of the Kanawha River, and occupying about 3,150 feet of the river shoreline in three separate sections between river mile points 54 and 55. The plant is divided into four non-contiguous areas (Figure 1). Three areas along the river shoreline are: 1) the upstream original plant site housing the chlorine and related production units; 2) the process development and quality control laboratory; and 3) the downstream site housing the chlorinated dry bleach production units. The fourth area is inland adjacent to the old Naval Ordinance Depot. The administrative offices, the hydrogen peroxide production units, and a fly ash lagoon are located on this area.

The FMC Inorganic Division plant has been in operation in South Charleston since 1915. Plant conditions have changed a great deal over the years as three production units have been

D-2


N
KANAWHA
RIVER
FLOW
MILE POINT 54.7
BLAINES
ISLAND
FMC-LAB
RESIDENTIAL AREA
UNION CARBIDE CORP.
AVE., SW
AREA - 3
RESIDENTIAL AREA
AREA - 2
MACCORKLE
RESIDENTIAL AREA
ADMINISTRATION AREA
CHARLESTON ORDNANCE CENTER
AREA- 1
FLY ASH LAGOON
PRODUCTION FACILITIES
RESIDENTIAL AREA
R.R.
YARDS
CHARLESTON
KANAWHA
FLOW
RIVER
SOUTH CHARLESTON
•-FMC-PLANTS
VICINITY MAP
0 5 10
MILES

NOTE: See report for a description of Area 1, 2 & 3.

JULY, 1972

FIGURE 1

FMC CORPORATION INORGANIC CHEMICALS DIVISION
SOUTH CHARLESTON PLANT
GENERAL PLAN - PLANT FACILITIES

shut down for economic reasons, the hydrogen peroxide and dry bleach production units have been added, and most other units have undergone major construction to increase efficiency and capability.

Employment is fairly stable at just under 1,000 persons. The plant operates 24 hours per day, 365 days per year.

The FMC Inorganic Division Plant manufacturing includes the following products: hydrogen peroxide, liquid anhydrous ammonia, caustic sodas, chlorine gas, chlorine liquid, and chlorinated dry bleach. The amount of production was not ascertained. Raw materials for manufacture include salt brine, coal, urea, sulfur, and methane (natural gas). Originally brine wells at the plant site were used for chlorine-caustic soda production; however, brine is now barged from a more concentrated supply at Ben's Run, West Virginia.

WATER USAGE

The FMC Inorganic Chemicals Division plant reported in its Refuse Act permit application that it uses 3.15 mgd of city water and 180.9 mgd self-supplied water from the Kanawha River. The reported water use was 176.4 mgd for cooling water, 1.54 mgd for boiler feed, 6.05 mgd for process water, and 0.06 mgd for the plant sanitary system. The total reported usage is not compatible with reported discharges, totaling 91 mgd. The cooling water usage reported is perhaps the potential available rather than that actually used. The company has stated that its water use is stable.

WASTEWATER DISCHARGES AND WASTE SOURCES

The FMC Inorganic Chemicals Plant discharges its sanitary wastes (0.06 mgd) to the South Charleston municipal waste treatment system. Approximately 0.75 mgd is lost to evaporation and 0.01 mgd is consumed in chemical processes. The remainder (91.1 mgd) of the water used is discharged to surface waters.

The Company lists 29 wastewater discharges to surface waters. Twenty-eight of these are directly to the Kanawha River and one is to Davis Creek, tributary to the Kanawha at river mile point 53.2. The discharge locations are shown on Figure 2. Table 1 lists the discharges, by the numbers shown on the Refuse Act permit application, along with the source area and discharge volume of each.

Except for the fly ash pond (outfall No. 029) the FMC Inorganic Chemicals Division plant has no formal treatment facility. As stated earlier, the sanitary wastes go to the South Charleston waste treatment system. Thirteen of FMC's discharges (003 through 015) lie within a stretch of 200 feet. Outfall No. 003 (from the turbine condensers, rectifiers, steam processing, brine treatment, and boiler water treatment) has a discharge of 26.2 mgd. Outfall No. 018 (from the chlorine and caustic diaphragm cells, and sulfur

D-5

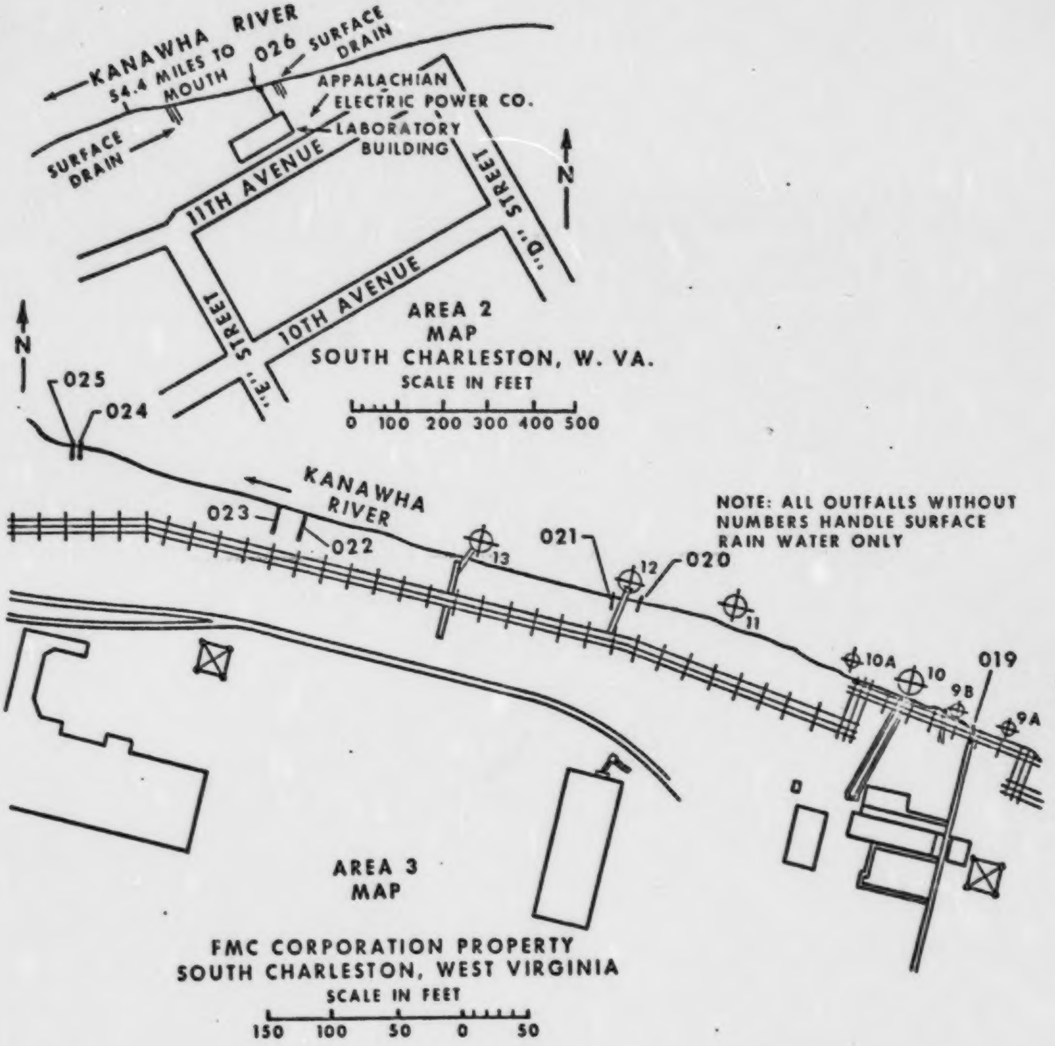

KANAWHA RIVER
54.4 MILES TO MOUTH
026
SURFACE DRAIN
APPALACHIAN ELECTRIC POWER CO.
LABORATORY BUILDING
SURFACE DRAIN
11TH AVENUE
10TH AVENUE
"D" STREET
"E" STREET
N
AREA 2 MAP
SOUTH CHARLESTON, W. VA.
SCALE IN FEET
0 100 200 300 400 500
N
025
024
KANAWHA RIVER
023
022
13
021
12
020
11
10A
10
019
9B
9A
NOTE: ALL OUTFALLS WITHOUT NUMBERS HANDLE SURFACE RAIN WATER ONLY
AREA 3 MAP
FMC CORPORATION PROPERTY
SOUTH CHARLESTON, WEST VIRGINIA
SCALE IN FEET
150 100 50 0 50

FIGURE 2
LOCATION EXISTING OUTFALLS

TABLE 1

WASTEWATER DISCHARGES SOURCES AND VOLUME

FMC Inorganic Chemicals Division

Outfall No.	Source Area	Discharge Volume (mgd)
001	Raw water intake	0.091
002	Steam condensate drain	0.22
003*	Turbine condensers, rectifiers, steam processing, brine treatment, boiler water treatment	26.2
004	Barometric condenser	1.01
005	" "	1.64
006	" "	0.50
007	" "	0.44
008	" "	0.44
009	Inactive	0.0
010	Barometric condenser	3.85
011	" "	2.09
012	" "	0.61
013	Vacuum seal for vacuum filters	0.43
014	Inactive	0.0
015	"	0.0
016*	Barometric condenser	1.14
017*	Caustic and chlorine coolers	4.1
018*	Chlorine and caustic diaphragm cells, sulfur recovery	38.9
019*	Carbon tetrachloride unit	3.3
020	Inactive	0.0
021	Inactive	0.0
022*	Ammonia production unit	0.5
023*	Carbon bisulfide unit	3.6
024	Ammonia production unit-vent scrubber	0.11
025	Air conditioning units	-
026	Laboratories	0.01
027*	Chlorinated cyanurate unit	0.50
028*	" " "	0.60
029*	Fly ash lagoon, hydrogen peroxide unit	0.9
	Total average effluent flow	91.181

---

* Effluents sampled by EPA March 1-2, 1972

recovery system) has a 38.9 mgd discharge. These two outfalls account for over 71.5 percent of the total average effluent flow.

WASTE TREATMENT PROGRAM

Historical Development

According to the Company, several waste control projects were underway prior to the initiation of the state phased pollution control program in 1958. These earlier projects were designed to reduce production losses.

The company undertook steps in 1958 to meet the requirements of the State's phased program:

Phase I - (to be met by 1963)

1. The "Beaver Pond" (fly ash lagoon) land was purchased and a 29-acre settling basin was constructed to contain boiler fly ash.
2. The East Plant (Area Three) collection system and mile long pipeline for wastes transfer was built.
3. All sanitary wastes were segregated and pumped to the South Charleston municipal treatment plant.
4. A spill alert system was established by the company.

Phase II - (to be met 1969)

1. Largest plant outfall was submerged.
2. A new brine source (Ben's Run) eliminated high magnesium and chloride wastes.

3. A sulfate purge system was installed to reduce chloride wastes.
4. Process changes were made to recover waste salt and caustic soda.
5. An oil and solvent recovery system was installed.

Phase II (to be met by 1972)

1. Elimination of all visual pollution, including foams and scum.
2. Reduce the BOD_5 load to a maximum of 1,000 pounds per day.
3. Reduce the oxidizable nitrogen load by 65 percent.
4. All wastes are to be neutralized to comply with water quality criteria in the Kanawha River.
5. All taste and odor producing materials must be reduced to meet water quality criteria for the Kanawha River.

Existing Waste Treatment Facilities

FMC Corporation operates a landfill and a 29-acre pond as waste disposal facilities. In-plant recovery and pollution abatement systems include an oil and solvent recovery system and a sulfate purge system.

Landfill

The bottom ash, waste asbestos, and other plant solid wastes are landfilled on the FMC property.

Wastewater Disposal

The Inorganic Chemicals Division of FMC Corporation has 29 wastewater discharges. The fly ash lagoon discharge to Davis Creek is less than one percent of the total discharge of the plant.

WWTP Description

The company operates the 29-acre "Beaver Pond" for the disposal of boiler fly ash, insoluble wastes from water and brine treatment, oil separator effluent, and effluent from the hydrogen peroxide plant. Although not confirmed by EPA or State analysis, the pond is claimed by the company to be effective in removing organics. The effluent volume average is 0.9 mgd from this facility.

The cooling water discharges total over 90 mgd from the 28 outfalls on the Kanawha. The exact portion of leaks and miscellaneous process wastewater has not been ascertained.

Cooling Water

The non-contact cooling water volume is estimated at 70 mgd, with a remaining 20 mgd being contaminated by spills, leaks, contact cooling, and process wastes. Recycle cooling water systems have not been utilized at this location.

Monitoring

The present monitoring program consists of two-hour grab samples composited over a 24-hour period once per month at each outfall. Special samples are also collected at major outfalls on a periodic basis.

Efficiency of Waste Treatment

The total waterborne raw waste loads of the FMC Inorganic plant are not known precisely but can be estimated as equivalent to that of the sanitary system, plus the influent to the "Beaver Pond", plus the effluent from the 28 discharges to the Kanawha River.

There is no treatment of the 28 discharges except for inplant process controls, solvent recovery, and oil separation where needed. The sanitary wastes are discharged to the South Charleston treatment plant. The waste entering the "Beaver Pond", contains 2.5 percent (25,000 mg/l) suspended solids and the effluent contains an average of 5 mg/l. The removal efficiency for other constitutents is not known.

Spill Potential

The spill potential of the three areas of the South Charleston Plant is critical. According to plant personnel, the plant has had six spills to the river, the character and amount unspecified. However, the spills were given immediate attention and treated as plant emergencies. The effects on the Kanawha River of spills from this plant have not been ascertained. A formal spill alert system was established in 1963. If a spill does occur at any of the three production areas, there is no provision to capture and retain any liquid lost.

Future Plans

The most significant waterborne waste problem of the FMC Inorganic Chemicals plant is ammonia-bearing wastes. In the manufacture of dry bleach, much "off gas" is produced in the calcining of urea. This is the source of two-thirds of the waterborne ammonia waste, and presently a pilot operation is underway to burn the gas and destroy the ammonia. If successful, this method will satisfy the 65 percent reduction requirement of the Phase III program.

NFIC-CINCINNATI FIELD SURVEY

Sampling

In order to ascertain the magnitude of waste constitutent discharge loadings, the EPA conducted a 24-hour sampling survey of selected effluents (see Table 1) from the FMC Inorganic Chemicals plant on March 1 - 2, 1972. Two-hour grab samples were composited and split with the company. The analytical results, converted to pounds per day, are listed in Table 2. Unfortunately, measurements of biochemical oxygen demand were not made because of an overload in the EPA laboratory.

TABLE 2

NET LOADINGS - LBS/DAY

FMC and EPA DATA

Company Outfall	COE Number	MGD	SOLIDS Total	SOLIDS Suspended	COD	TOC	TKN	NH_3	Cl^-	OIL & GREASE
4	(003)	18.0	17,724 (17,264)	3,154 (4,053)	2,164 (1,801)	Nil (150)	--	--	7,349 (7,956)	--
18	(016)	1.1	---	---	132 (46)	--	--	--	10 (18)	--
19	(017)	3.2	111,221 (108,805)	-80 (187)	310 (3,307)	--	--	--	43,852 (43,648)	ND (27)
22 + SR	(018)	39.4	159,554 (144,582)	5,253 (6,245)	7,551 (8,872)	--	--	--	58,812 (63,418)	ND (329)
26	(019)	3.8	3,097 (2,218)	- 348 (127)	--	Nil (1,585)	--	--	1,703 (1,458)	--
33	(022)	.26	2,706 (7,848)	- 119 (2)	7 (2)	--	32.9 (33.6)	31.9 (27.1)	25 (45)	--
34	(023)	1.9	4,631 (4,278)	- 10 (48)	1,422 (1,506)	--	-3 (1.6)	--	- 11 (1,837)	Nil (32)
40	(027)	.54	55,231 (48,774)	2,249 (1,995)	157 (315)	4,849 (5,458)	952 (15,292)	0 (7,198)	27,218 (162)	ND (22)
41	(028)	.67	64,571 (78,397)	--	189 (1,342)	8,704 (5,543)	18,452 (1,232)	8,554 (38)	1,551 (29,157)	ND (50)
1-D	(029)	1.2	39,376 (37,669)	--	834 (1,482)	12 (30)	2.5 (4.0)	--	22,887 (28,551)	ND (0)

Note: EPA data in parentheses

Analysis

Comparison With Others

The analytical results were reasonably consistent between laboratories except for the samples from outfalls 027 and 028 with respect to nitrogen and chlorides, and outfalls 017 and 028 with respect to chemical oxygen demand. The company indicates that EPA data for Outfalls 027 and 028 nitorgen and chloride appears to be reversed.

Confirmation of Reported Data

Total plant loadings are comparable and in line with data reported to the State in 1971 (averages shown in Table 3). Arsenic, nitrogens, and COD were not reported to the State in 1971.

Major Sources and Loads

The FMC Inorganic plant is a large discharger of dissolved solids, COD, total organic carbon, ammonia, Kjeldahl nitrogen, and chlorides. The largest sources of solids and COD are the caustic and chlorine units (Outfalls Nos. 017 and 018), the dry bleach units (Nos. 027 and 028), and the "Beaver Pond."

The largest sources of COD and chloride is the chlorine and caustic plant (No. 018). Chloride is also high from the chlorinated dry bleach (No. 027) plant and the "Beaver Pond" (No. 029). Large

TABLE 3

PLANT EFFLUENT - NET LOADS (POUNDS/DAY)

FMC CORPORATION - INORGANIC CHEMICALS DIVISION
South Charleston, West Virginia

	CFIC Survey March 1972			FMC Report to State
Parameter	EPA	FMC	STATE	1971 (9 Months)
Total Solids	449,830	458,100	478,800	366,100
Susp. Solids	12,660	10,100	1,000	8,514
Chlorides	176,250	163,400	209,000	163,270
COD	18,670	12,770	No result	
TOC	12,775	13,565	No result	
TKN	16,560	19,440	21,840	
NH_3	7,260	8,590	5,420	
Oil & Grease	460	Nil	No result	
Chlorine	No result		7,940	5,575
Sulfide	> 76.0			
Mercury	.017			
Chromium	16.5			21.4
BOD_5				1,877

Total net discharge loadings with primary associated outfalls are as follows:

Parameter:	Net lbs/day	Outfalls
Tot. Solids	449,830	003, 017, 018, 027, 028
Susp. Solids	12,660	003, 017, 018, 027
COD	18,670	003, 017, 018, 023, 028, 029
TOC	12,775	019, 027, 028, 029
TKN	16,560	027, 028
NH_3	7,260	027
Oil & Grease	460	018 (all concentrations are less than 10 mg/1)
Chlorides	176,250	003, 017, 018, 028, 029
Sulfide	> 76.0	022

quantitites of total organic carbon and nitrogen originate in the dry bleach plant (Nos. 027 and 028).

Oil and grease discharges appear to be well under control at the FMC plant.

Plant data reported to the state in 1971 showed an average of about 1,900 pounds per day BOD_5 discharged to the river. The Refuse Act permit application indicates that most of the BOD load (1,400 pounds per day) is discharged via Outfall No. 018 from the chlorine caustic plant, which is indicated by the high COD value observed in that outfall.

Metals analyses of the pond effluent (No. 029) showed 16 pounds per day chromium and 0.5 pounds per day arsenic, assumed to be associated with the fly ash.

Toxicity of Effluents

Static bioassay tests, using fathead minnows, were made on the effluent from Outfall No. 018 from the chlorine and caustic plant in March, 1972. The tests were made in a dissolved oxygen range of 5.1 to 5.9 mg/l, pH 2.9 to 6.4, and temperature between 23 and 27°C. The median tolerance limit (TL_m) wastewater percentage at 24 hours was 78 percent, at 48 hours it was 60 percent, and at 96 hours, 56 percent. The TL_m is the percentage of wastewater by volume which will kill 50 percent of the test organisms in the specified time.

Other effluents from the FMC Inorganic Chemicals plant were not tested for toxicity.

Anomalies

The analytical results would indicate that the samples for Nos. 027 and 028 could have been interchanged. The discharge volumes for these outfalls is 0.54 mgd and 0.167 mgd respectively. Since these volumes are nearly equal and less than 1.0 mgd, the total difference in net loadings should be considered negligible when compared to the total plant discharge of over 90 mgd.

CONCLUSIONS

Six discharges from the FMC Corporation's Inorganic Chemical Division contain high dissolved solids (003, 017, 018, 027, 028, and 029). The 028 discharge contains the major portion of the nitrogen load from the South Charleston plant.

RECOMMENDATIONS

It is recommended that:

1. The FMC Inorganic Chemicals Plant take immediate steps to separate suspended solids, COD, and total organic carbon wastes from wastewater streams, particularly from outfall Nos. 033, 018, 023, and 027, and route these wastes to the fly ash pond.

2. Efforts toward reduction of nitrogenous wastes continue, including but not limited to the present ammonia-bearing project, to the extent that at least 65 percent of the waterborne raw nitrogenous load is removed before discharge to surface waters.
3. Toxicity of effluents be reduced at least to the point that no discharge, undiluted, exceeds the 96 hour TL_m.
4. BOD_5 discharge loads be reduced at least to a total of no more than 200 pounds per day in order to the Kanawha River to meet the DO criteria of 4 mg/l at the existing seven day, once-in-ten-year low flow.

KANAWHA RIVER
INVESTIGATION OF WATER QUALITY
AND
WATER POLLUTION CONTROL PRACTICES

VOLUME II

REPORTS OF INDUSTRIAL INVESTIGATIONS
ON SEVEN INDUSTRIES

E

E. FMC Corporation
AMERICAN VISCOSE DIVISION
NITRO, WEST VIRGINIA

United States Environmental Protection Agency
Office of Enforcement and General Counsel
National Field Investigations Center - Cincinnati
and
Region III - Philadelphia
July, 1973

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REPORT OF INDUSTRIAL INVESTIGATION

FMC CORPORATION, AMERICAN VISCOSE DIVISION

NITRO, WEST VIRGINIA

GENERAL PLANT DESCRIPTION

The FMC Corporation American Viscose Division plant is located on the Kanawha River at Nitro, 12 miles downstream from Charleston at river mile point 42.7. The plant lies entirely on the right side of the river (facing downstream) and occupies about 2,200 feet of shoreline. The plant area is approximately 120 acres. Figure 1 shows the general plant layout. The plant is in an area surrounded by other chemical plant operations. The adjacent ones are the Allied Chemical Company upstream and FMC Organic Chemicals Division downstream.

The FMC American Viscose Division began operation in 1938. Modifications and expansions have occurred over the years, but there has been no change in the basic manufacturing process of the principal products, rayon staple. The Viscose process is named from the thick viscosity of the intermediate product.

Employment has fluctuated between 850 and 1,150 and is currently 1,100. The plant operates 24 hours a day, 365 days

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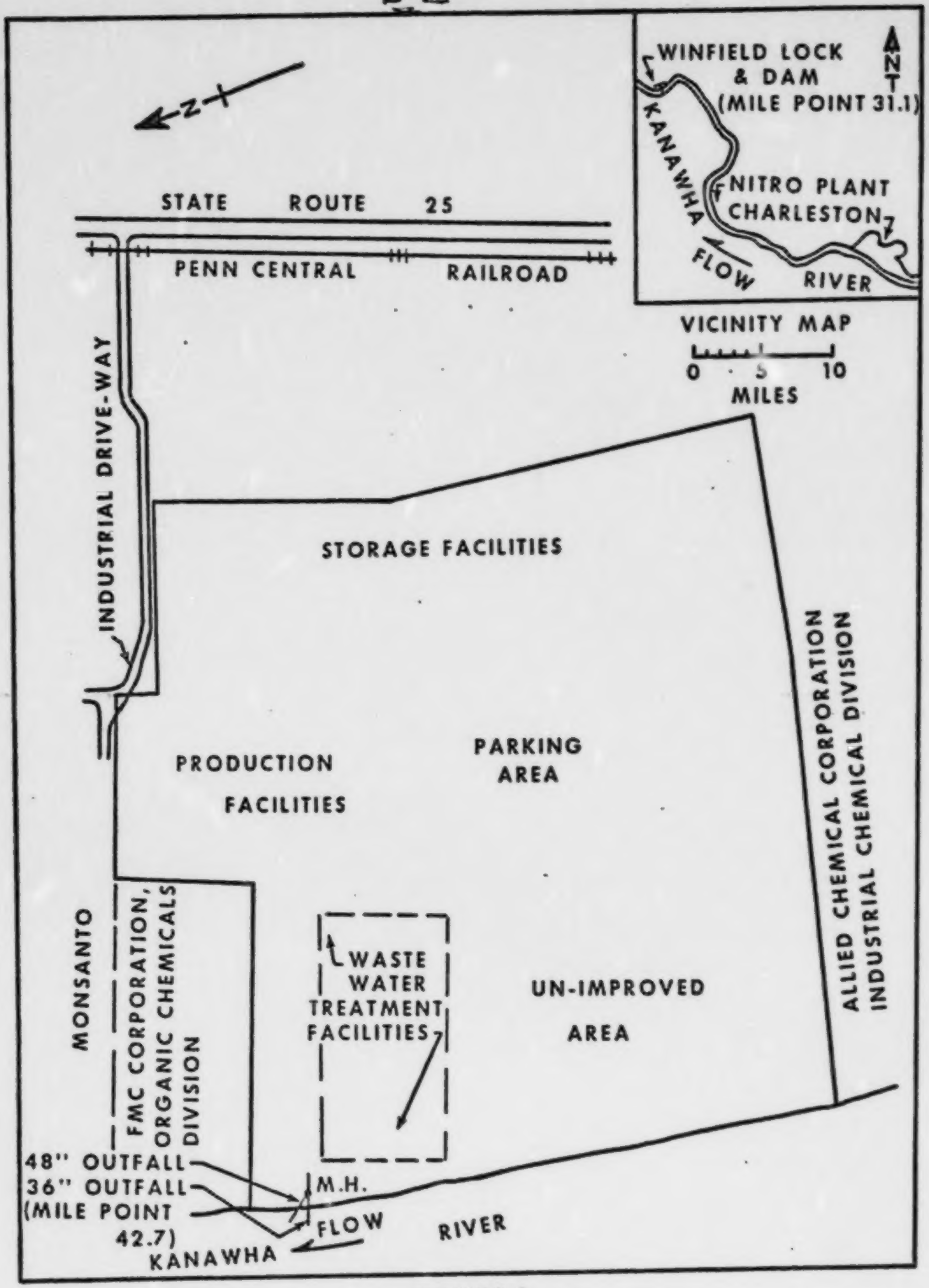
N
STATE ROUTE 25
PENN CENTRAL RAILROAD
INDUSTRIAL DRIVE-WAY
WINFIELD LOCK & DAM (MILE POINT 31.1)
KANAWHA
NITRO PLANT
CHARLESTON
FLOW
RIVER
VICINITY MAP
0 5 10
MILES
STORAGE FACILITIES
PRODUCTION FACILITIES
PARKING AREA
ALLIED CHEMICAL CORPORATION INDUSTRIAL CHEMICAL DIVISION
MONSANTO
FMC CORPORATION, ORGANIC CHEMICALS DIVISION
WASTE WATER TREATMENT FACILITIES
UN-IMPROVED AREA
48" OUTFALL
36" OUTFALL
(MILE POINT 42.7)
M.H.
FLOW
RIVER
KANAWHA

FIGURE 1
FMC CORPORATION
AMERICAN VISCOSE DIVISION
GENERAL PLAN - PLANT FACILITIES
JULY 1972

per year at an average of about 80 percent of its rated capacity of about 230 million pounds of rayon staple per year. A significant by-product is sodium sulfate.

Basic raw materials include highly refined cellulose sheet pulp, caustic soda, carbon bisulfide, sulfuric acid, and zinc sulfate. Sulfuric acid is supplied by the plant's upstream neighbor, the Allied Chemical Company.

WATER USAGE

The FMC American Viscose Division purchases city water (Nitro water plant) at an average rate of 20,000 gallons per day for domestic purposes. The plant pumps an average of about 35 mgd from the Kanawha River. Approximately 25 to 30 percent of this water is treated by standard precipitation, settling, filtration, and chlorination for process water. Ten to 15 percent is further softened for process and boiler feed purposes.

The Refuse Act permit application indicated that the company uses 26 mgd as cooling water, 1 mgd for boiler feed, 6.5 mgd process water, 0.06 mgd in its sanitary system, and 1.46 mgd for other purposes. The application also indicates that 0.4 mgd is lost to evaporation and the rest is discharged to the Kanawha River.

WASTEWATER DISCHARGES AND WASTE SOURCES

The FMC American Viscose Plant has only one sewer to the Kanawha River through which all of its wastewaters are discharged, both industrial and sanitary. The sewer leads to a sump on the river bank which has two outfalls, one above water called the "secondary outfall" and a submerged 36-inch pipe extending 100 feet into the river called the "primary outfall". Under normal operating conditions, all wastewaters are discharged via the submerged outfall. Its location is usually recognizable by a surface boil in the river. The total discharge from the outfall is about 35 mgd. At the time of this investigation, the discharge was entirely untreated: 26 mgd cooling water and 9 mgd process water.

Information regarding specific unit sources of wastes has not been provided by the FMC American Viscose Division.

WASTE TREATMENT PROGRAM

Historical Development

The Company reports that it began a program several years ago of separating process and cooling water wastes. An aeration lagoon was constructed which provided partial secondary treatment to about 1 mgd of selected process and sanitary wastes. The lagoon was abandoned prior to this investigation and all waterborne production and sanitary wastes are discharged without treatment.

The history of waste treatment at the FMC American Viscose plant is one of non-compliance with requirements of the State phased program.

The principal requirements of Phase I and Phase II were reductions of BOD_5 loading to the Kanawha from 9,300 pounds per day to 2,800 pounds per day by June 30, 1966. This date was later extended by the State to June 30, 1967, for all Kanawha industries. The FMC American Viscose plant did not comply with the loading limitations. West Virginia Pollution Control Permit No. 4384 was issued to the plant on February 7, 1972, and included Phase III requirements, which in turn included a BOD_5 limitation of 2,000 pounds per day and limited acidity to 80,000 pounds per day by December 31, 1972.

The company agreed in a letter to the state in July, 1971, to meet the Phase III requirements by December, 1972, with the construction of a secondary biological treatment facility. Since that time the Environmental Protection Agency, Region III, has been negotiating with the company bo obtain a commitment letter toward meeting the company's pollution control obligations.

Existing Waste Treatment Facilities

As stated earlier, the FMC American Viscose plant has no facility in operation for the treatment of waterborne waste loads.

Landfill

The company reports that a portion of the plant property is used for solid waste disposal. The area has a small pond, presumably receiving leachate from the disposed material, which overflows into an outfall of the adjoining Fike Chemical Company. The pond effluent was recently found to have a very high pH of 13 units.

Wastewater Disposal

The company has recently constructed facilities for waste disposal.

Monitoring

The present monitoring program consists of one monthly composite sample which is analyzed for BOD_5, total solids, suspended solids, chloride, and zinc. These results are reported to the State as net loadings.

Efficiency

Without waste treatment facilities during the survey, the efficiency of treatment was zero and the discharge to the river equalled the raw waterborne waste load.

Spill Potential

The FMC American Viscose Division states that spills have been insignificant due to good housekeeping and the nature of the process and chemicals used. Any rejected batches of alkali cellulose crumbs or viscose solution are landfilled on company property.

Tanks holding caustic and sulfuric acid are not diked, but are a long distance from the river. Materials such as CS_2 and the amine-phenol mixture are handled in well-designed equipment with good safeguards to minimize spill dangers.

Future Plans

The FMC American Viscose plant reports that it is separating as much as possible the process wastes from the large volume of cooling waters. It is expected that this will result in a volume of about 9.3 mgd process wastewater.

The FMC American Viscose Division has recently submitted a proposed treatment plant design to the EPA, Region III. The company has provided target criteria for the proposed facility as shown in Table 1. Calculated removal efficiencies, based upon loads reported to the state (Table 2), are also shown.

TABLE 1

FMC Proposed Treatment Unit Effluent Quality
Design Flow 6,500 gpm (9.3 mgd)

Constituent	mg/l	lbs/day	Removal Efficiency
BOD_5	30	2,340	80 percent
COD	243	18,954	60 percent
Suspended Solids	30	2,340	84 percent
Dissolved Solids	10,000	780,000	0 percent
Zinc	5	390	95 percent
pH	6.0 - 8.5 units	-	-

The loadings in Table 1 along with the following implementation schedule have been reviewed by EPA, Region III.

1. Activated Sludge Unit and Zinc Removal:

    Complete construction - February 1, 1973
    Start-up - March 1, 1973
    Operational - April 1, 1973

2. Acid reclaim cooling tower system:

    Operational date - July 1, 1973

In comparison to requirements imposed upon other industries in the Kanawha Valley, the loading limitations for the BOD_5 allowed is higher than that of the Phase III program (2,000 pounds per day).

The company has provided the following specifics of its proposed program:

1. Two primary clarifiers will be installed for zinc removal each at two-thirds of total design requirement.
2. Zinc hydroxide sludge will be dewatered by two rotary vacuum filters and then disposed to landfill.
3. Blowdown from acid reclaim cooling tower will be pumped to waste treatment from No. 2 lift station.
4. A thickener will be installed ahead of the aerobic digestion chamber allowing installation of a 20-day detention chamber at half of the earlier designed volume.

5. Construction underway includes (a) three lift stations, (b) excavation for aeration chambers and final clarifier, and (c) yard grading.

The determination of the adequacy of the program must await construction after which its control efficiency can be judged.

NFIC-CINCINNATI FIELD SURVEY

Sampling

In order to ascertain and/or confirm the magnitude of waste constitutent discharge loadings, the EPA conducted a 24-hour sampling survey of the single discharge and the plant's raw water intake on March 21 - 22, 1972. Two-hour grab samples were composited and split with the company and the State Division of Water Resources. The analytical results, converted to pounds per day net loadings, are listed in Table 2. For comparison average loadings of constitutents reported to the state for the first nine months of 1971 are included.

Analysis

The survey results were reasonably consistent between laboratories except for BOD_5, suspended solids, and phenol. The company measured much higher BOD_5 and lower suspended solids and phenol. Tabulated values are in line with the data reported to the state in 1971, taking into account reasonable loading variability with time.

TABLE 2

TOTAL WATERBORNE WASTES

AMERICAN VISCOSE PLANT
Nitro, West Virginia

Net Loads - Pounds/Day

	NFIC Survey March 1972			Viscose Report to State 1971 (10 Months)
Parameter	EPA	STATE	VISCOSE	
BOD_5	7,570	7,920	13,450	11,287
BOD_{20}	18,915	16,920	25,900	No result
Total Solids	354,300	500,700	428,900	419,500
Susp. Solids	No result	13,500	3,950	14,300
Chloride	No result	36,300	26,800	13,450
Zinc	8,710	9,890	8,120	7,940
COD	31,200	No result	31,300	
TOC	9,610	No result	11,000	
TKN	360	609	550	
NH_3	0	405	No result	
Acidity	121,000	No result	103,210	
Phosphate	30	63	51	
Oil & Grease	270	-	282	
Phenol	3.0	3.4	0	
Cyanide	0	No result	0	
pH	2.2	2.2	2.5	

Major Sources and Loads

The loadings shown in Table 2, since they are untreated, indicate plant raw loadings to the river. The company discharges excessive loads of BOD, dissolved solids, zinc, COD, total organic carbon, and acidity.

Toxicity of Effluents

Static bioassay tests, using fathead minnows, were made on the FMC American Viscose outfall in March, 1972. The tests were made in a dissolved oxygen range of 5.3 to 6.2 mg/l, pH 2.6 to 5.8, and a temperature between 23 and 27°C. The median tolerance limit (TL_m) wastewater percentage at 24, 48, and 96 hours was 7.6 percent meaning that all of the kill occurred within the first 24 hours. The TL_m is the percentage of wastewater by volume which will kill 50 percent of the test organisms in the specified time. For the FMC effluent the toxic influence was likely the low pH of the initial sample.

Anomalies

It was anticipated that as in all other plants visited, the facilities could be toured to become familiar with the plant layout. Due to a problem in the production area, this request was not allowed at the time of this visit. It was agreed, however, that sampling could be performed on a day to be mutually selected and this would encompass the single plant outfall and the raw water intake. Response to the questionnaire was received on April 14, 1972. The overall replies were very brief, and many questions were unanswered.

CONCLUSIONS

The American Viscose Division Plant of the FMC Corporation has historically discharged a toxic wastewater to the Kanawha River. The pollutional effects of a 2.2 pH, over 400,000 pounds per day of dissolved solids and more than 8,000 pounds per day of zinc in the plant effluent are severe.

RECOMMENDATIONS

It is recommended the FMC Corporation, American Viscose Division:

1. Segregate from cooling waters and route to treatment plant all waste streams to which are added BOD, COD, organic carbon, oil and grease, nitrogeneous wastes, and suspended solids.
2. Reduce the toxicity of its effluent at least to the point that it does not exceed, undiluted, the 96 hour TL_m for standard test organisms.
3. Neutralize or otherwise treat its acid load to the river such that the discharge pH is maintained within a range of 6.0 to 8.5
4. Reduce the BOD_5 load to the river equitably with other industries in the Kanawha Valley.

KANAWHA RIVER
INVESTIGATION OF WATER QUALITY
AND
WATER POLLUTION CONTROL PRACTICES

VOLUME II

REPORTS OF INDUSTRIAL INVESTIGATIONS
ON SEVEN INDUSTRIES

F. FMC Corporation

Organic Chemicals Division

Nitro, West Virginia

F

United States Environmental Protection Agency

Office of Enforcement and General Counsel

National Field Investigations Center - Cincinnati

and

Region III - Philadelphia

July, 1973

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REPORT OF INDUSTRIAL INVESTIGATION

FMC CORPORATION

ORGANIC CHEMICALS DIVISION

NITRO, WEST VIRGINIA

GENERAL PLANT DESCRIPTION

Figure 1 shows the location of the plant on the right bank of the Kanawha River in the Nitro, West Virginia, area. The plant borders the Monsanto Company on the north and the FMC American Viscose Division on the south. Detailed information on the plant area, buildings, etc., were not made available for this survey.

The plant employs about 170 people. Since 1960, employment has ranged from a maximum of approximately 475 to a low of 150.

Production quantities and sales are confidential. In 1970 the major products were plasticizers and phosphorous chemicals, and the principal raw materials were phosphorous, chlorine, caustic, phenol, cresylic acids, glycol ethics, organic alcohols, and propylene. Production has varied with many product additions and deletions. Tributyl phosphate and tributoxyethyl phosphate were added in 1960, phosphorous tri and oxychlorides in 1962, methyldiphenyl

F-2

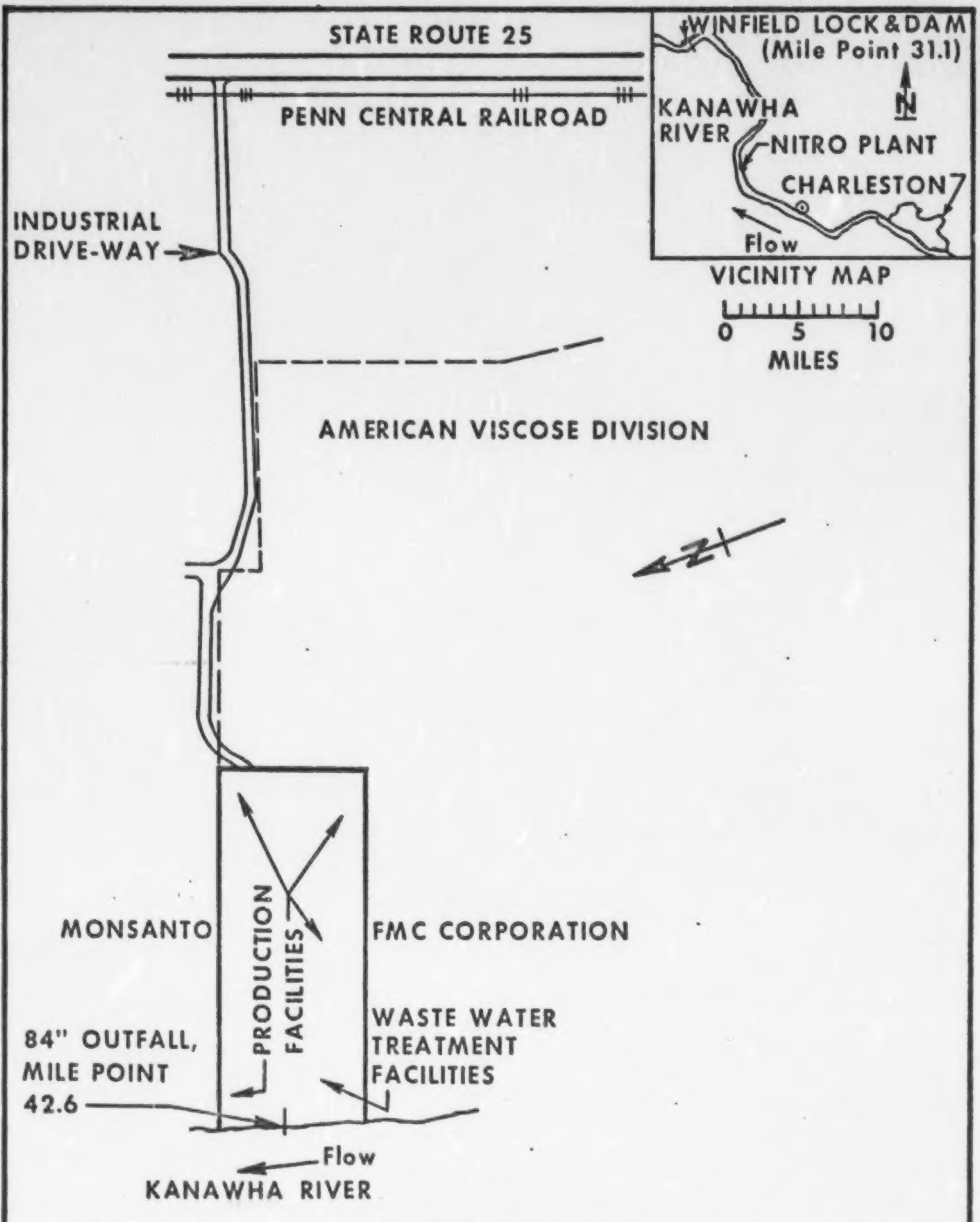
STATE ROUTE 25
PENN CENTRAL RAILROAD
INDUSTRIAL DRIVE-WAY
AMERICAN VISCOSE DIVISION
N
MONSANTO
PRODUCTION FACILITIES
FMC CORPORATION
WASTE WATER TREATMENT FACILITIES
84" OUTFALL, MILE POINT 42.6
Flow
KANAWHA RIVER
WINFIELD LOCK&DAM (Mile Point 31.1)
N
KANAWHA RIVER
NITRO PLANT
CHARLESTON
Flow
VICINITY MAP
0
5
10
MILES

FIGURE NO. 1 FMC CORPORATION
ORGANIC CHEMICALS DIVISION NITRO, WEST VIRGINIA
GENERAL PLAN-PLANT FACILITIES

phosphate in 1964, and isopropylphenol phosphates in 1969. In the past decade aluminum chloride and allyic esters production have been eliminated.

The plant operates 24 hours per day, 365 days per year.

The eight main production areas and sources of wastewater as shown in the Refuse Act Permit Application are:

1. Isopropyl Pehnol Area.
2. Kronitex Reaction - Distillation Area.
3. Kronitex Refining Area.
4. Tributoxyethyl Phosphate - Tributyl Phosphate Production Area.
5. Methyl Diphenyl Phosphate Production Area.
6. Butyl Cellosolve Adipate Area.
7. Phosphorous Trichloride Production Area.
8. Phosphorous Oxychloride Production Area.

Figure 2 shows raw materials, intermediates, and products manufactured at the Nitro plant.

WATER USAGE

The following water use data are taken from the Refuse Act Permit Discharge Application for the Organic Chemicals Division at Nitro, West Virginia:

Source - Municipal System	0.33 MGD
- Kanawha River	3.98 MGD

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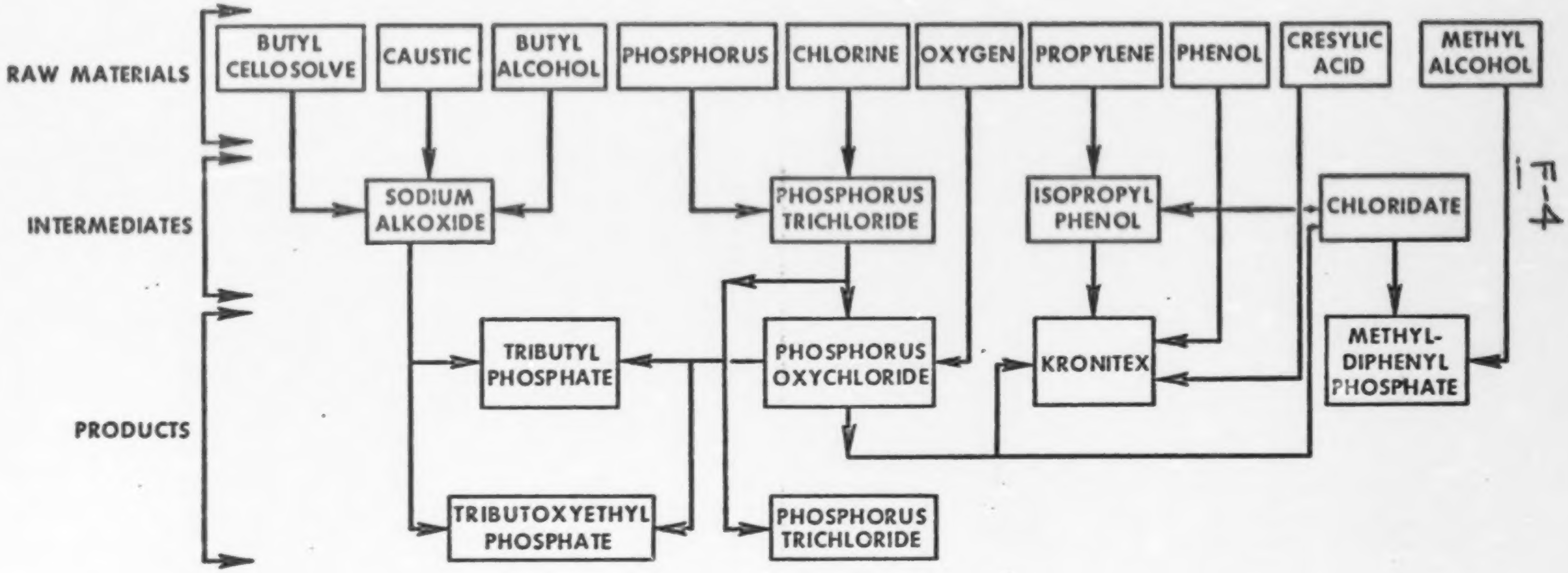
FIGURE 2

FMC CORPORATION - ORGANIC CHEMICALS DIVISION - NITRO PLANT, NITRO, WEST VIRGINIA

BUDGETED 1972 MATERIALS


RAW MATERIALS
INTERMEDIATES
PRODUCTS
BUTYL CELLOSOLVE
CAUSTIC
BUTYL ALCOHOL
PHOSPHORUS
CHLORINE
OXYGEN
PROPYLENE
PHENOL
CRESYLIC ACID
METHYL ALCOHOL
SODIUM ALKOXIDE
PHOSPHORUS TRICHLORIDE
ISOPROPYL PHENOL
CHLORIDATE
TRIBUTYL PHOSPHATE
PHOSPHORUS OXYCHLORIDE
KRONITEX
METHYL-DIPHENYL PHOSPHATE
TRIBUTOXYETHYL PHOSPHATE
PHOSPHORUS TRICHLORIDE

Use	- Cooling Water	4.01 MGD
	- Boiler Feed Water	0.09 MGD
	- Process Water	0.21 MGD
	- Sanitary System	.003 MGD

The sanitary system discharges to the municipal treatment plant and all other wastewaters are discharged to the Kanawha River.

The discharge flows on which this EPA study was based were:

Waste Treatment Plant	0.060 MGD
Cooling Water	3.615 MGD
Total Dishcarge	3.675. MGD

(Flows were estimated from water intake values.)

WASTE TREATMENT PROGRAM

Historical Development

The West Virginia Phased Program requirements for the Nitro Plant are shown in Table 1. The base load to the Kanawha River was established as 7,000 pounds BOD_5 per day in 1958.

TABLE 1

WEST VIRGINIA PHASED PROGRAM FOR

FMC ORGANIC PLANT AT NITRO

	% Reduction from Base	BOD_5 Limit lb/day	Phenol Limit lb/day	Acidity Limit(1) lb/day	Compliance Date
Phase I	40	4,200	900	35,000	6/30/63
Phase II	70	2,100	16	10,300	6/30/66
Phase III	86	1,700	16	(2)	12/31/72

NOTE: (1) As $CaCO_3$

(2) Acidic wastes must be sufficiently neutralized to comply with applicable water quality criteria in the Kanawha River.

Under Phase I with a compliance date of June 30, 1963, wthe following projects were completed:

1. Sanitary wastes were segregated from plant wastes and piped to the municipal treatment plant.
2. Alcohol recovery distillation recovery unit was installed to remove organics from the drown water.

Under Phase II with a compliance date of June 30, 1966, the following projects were completed:

1. Installed collection, neutralization, extended aeration, clarifier system.
2. Installed second alcohol recovery distillation system.
3. Installed hydrochloric acid absorbtion and purification sytem.
4. Installed condensers to remove organics from reactor vent streams.

Plans for Phase III compliance are discussed later in this section.

Existing Waste Treatment Facilities

Incineration, Landfill, and Deep Well Disposal

The Company, in response to NFIC-Cincinnati inquiry, has reported that some waste materials are incinerated off-site.

Incineration was the original method planned for Phase II requirements but the system was not satisfactory. No information was provided on any landfill or deep well disposal activity.

Wastewater Disposal

WWTP Description

The existing wastewater treatment plant consists of a neutralization tank, an aeration lagoon, and a settling basin. The aeration basin, installed in 1968, has a capacity of about 500,000 gallons.

During 1969 and the first half of 1970, the plant experienced mechanical and other operational problems with the new lagoon. At that time the characterization and segregation of all waste streams were incomplete. This was completed by mid-1972.

The company states that their abatement efforts to date have resulted in a large reduction in the plant waste load in spite of rising production rates. Figures 3 and 4 show the monthly averages of BOD_5 and phenol loads as reported to the State by FMC. The upset periods and overall decrease in loading to the river is evident. Figure 4 shows that the phenol problem has not been abated.

As to reduction of inorganic loadings, FMC reports that chlorides have been lowered by 30 percent and acidity by approximately 40 percent.

FIGURE 3
FMC ORGANIC - NITRO,W.VA.,PLANT
BOD$_5$ LOADS TO KANAWHA RIVER
1968-1972

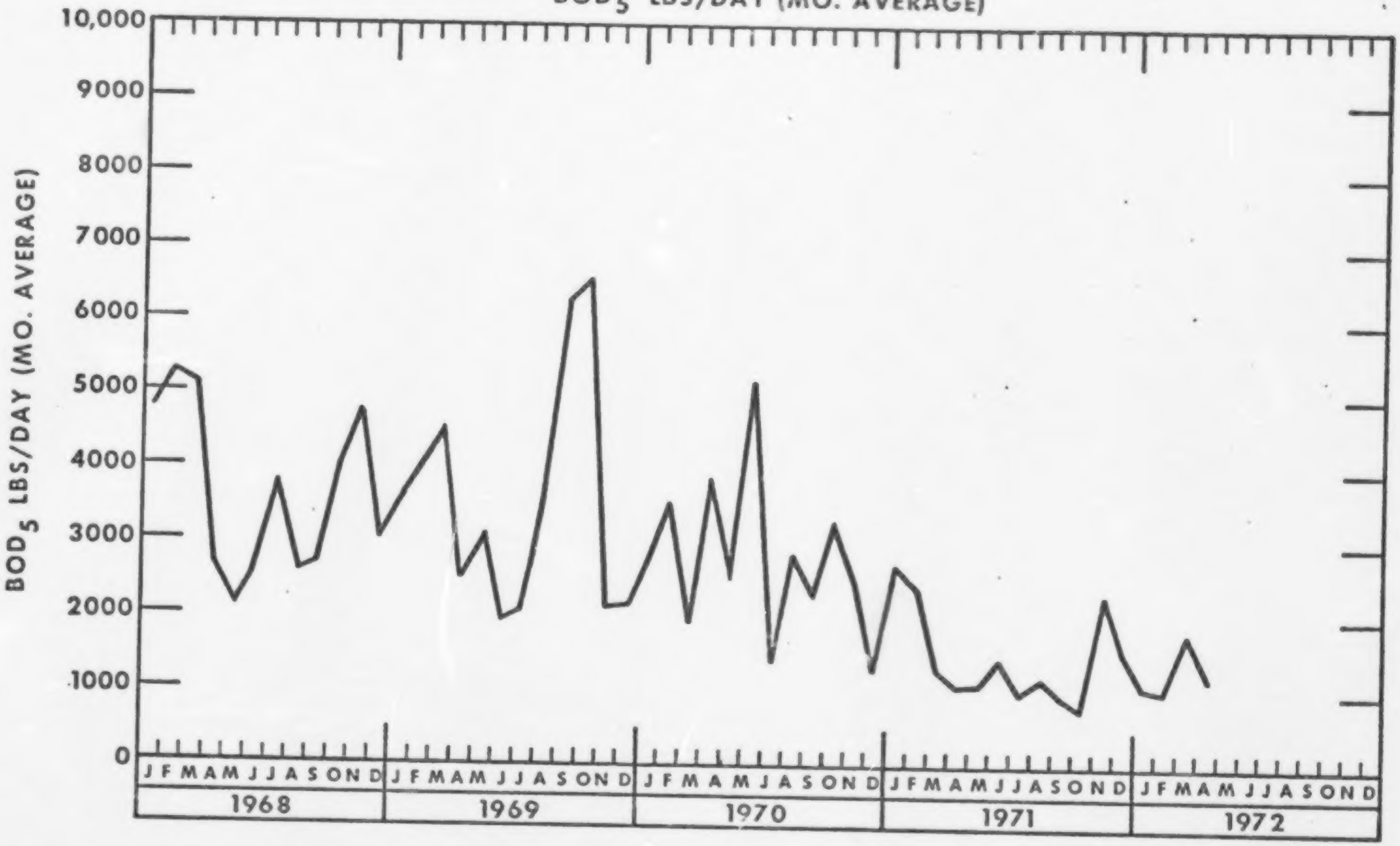
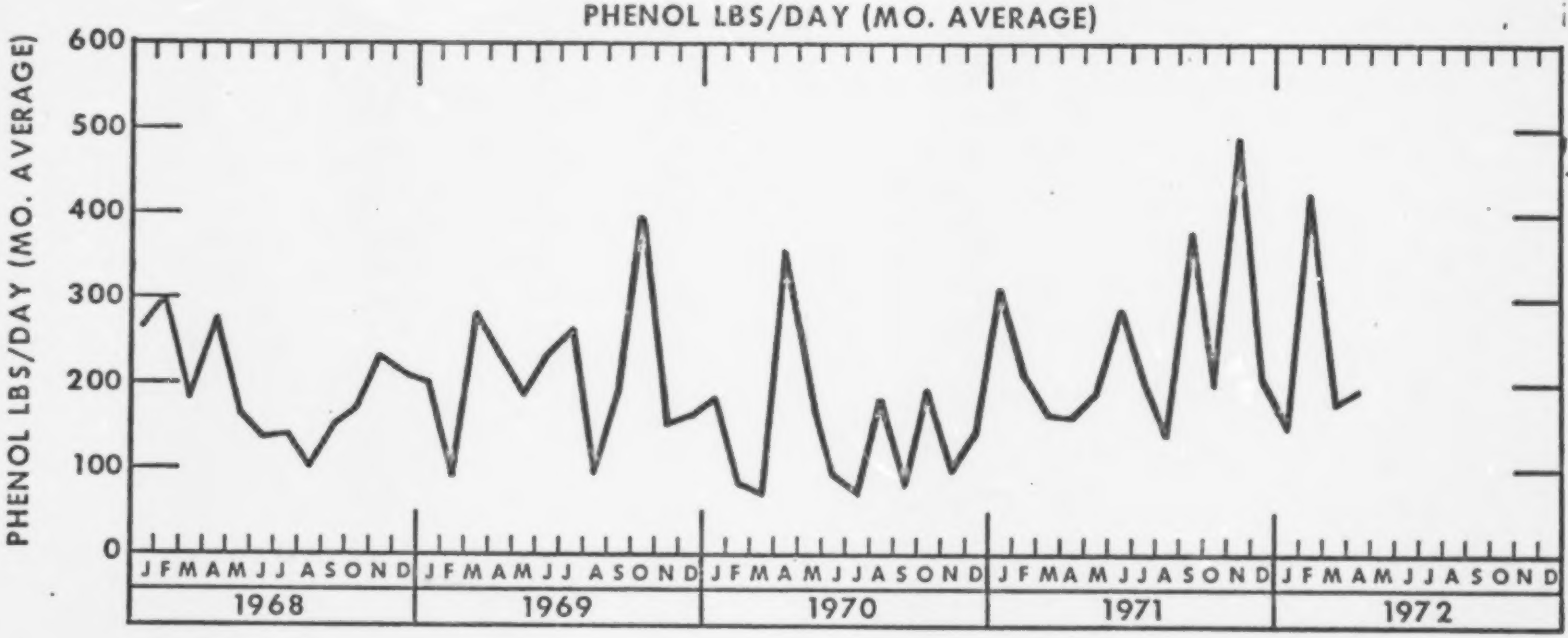


FIGURE 4
FMC ORGANIC - NITRO, W.VA., PLANT
PHENOL LOADS TO KANAWHA RIVER
1968-1972



FMC Organic reported that the following work was undertaken to meet the Phase III requirements:

1. An experimental high rate trickling filter is being tested in the plant to provide greater BOD and phenolic reductions.
2. Installation of in-plant plant improvements to concentrate phenolic and BOD bearing waste for treatment.
3. Installation of a floating boom at the outfall to retain scum or oils which might accidentally enter the sewer system.
4. Investigation of chemical and biological treatments on wastewater streams in combination with sludge handling studies necessary to meet Phase IV requirements.

Final design on planned imprpvements was not completed in mid-1972 and it was evident that the construction schedule for Phase III would extend to 1972. Costs of the new treatment work were estimated at $250,000 for 1972 and 150,000 for 1973 or a total expenditure of $400,000.

Cooling Water

Cooling water is pumped from the Kanawha River at a flow rate which has ranged from approximately 3.1 ro 4.9 MGD during a ten year period ending in 1972. Recent temperature measurements indicate a change in temperature of about 6°C. General plant cooling water contains no inhibitors other than chlorine. Cooling water is screened and intermittently treated with chlorine to prevent slime growth. This method has not changed in recent years. There are two small cooling towers. These are closed systems with very little loss, or blow down.

A significant portion of the total BOD_5 load discharged to the river was carried by the cooling water stream during the NFIC-Cincinnati survey in 1972. Results are given later in this report. Available records do not indicate what portion of the total load is typically carried by the cooling water.

Monitoring

The company has reported that twenty-four hour composites of the lagoon and main sewer streams are analyzed and that indicated corrective action is taken accordingly. Details on the analytical parameters were not provided.

Efficiency

Data on WWTP removal efficiencies are not available. The Company stated that the efficiency ranges from 50 percent to 90 percent. The ambient conditions are a critical factor with the efficiency dropping sharply in cold weather.

Spill Potential

Spills of materials are treated as a plant emergency. A formal notification procedure has been established with the State. There have been no recent spills in which it was necessary to notify the State under the notification procedure. No spills to the river of oil, refractory organics, ammonia, or high dissolved solids materials have been recorded.

From observations during the limited study period, NFIC-Cincinnati would judge the potential for spills to be moderate, and that pollution from spills generally would be evident in the cooling water stream. The results of the plant survey (see NFIC-Cincinnati Field Survey section of this report) indicate that the bulk of the BOD_5 load to the river was in the untreated cooling water waste stream, thus, high total load values could reflect a spill or leakage in plant equipment during the sampling period.

Future Plans

As with sales and production information, the FMC Corporation treats any plans for expansion, etc., or reductions in operations as confidential. Judging from the general knowledge that production has been increasing at the Nitro plant, the production future there appears to be good. There would appear to be a prospect of future expansion.

NFIC-CINCINNATI FIELD SURVEY

Sampling

A 24-hour sampling program was carried out on February 16 and 17, 1972. The 24 hour sample was composited from samples taken at two hour intervals, NFIC-Cincinnati also sampled for the State while the FMC Corporation personnel took their own samples on the same schedule. Sample points were:

1. Wastewater Treatment Plant inlet.
2. Wastewater Treatment Plant outlet.
3. Outfall (Combined WWTP and cooling water).
4. Nitro treated water.
5. Raw River Water.

The outfall is the only active discharge to the river. The plant's sanitary waste is discharged to the municipal sewer system and was not sampled. Sampling for bioassay tests was limited to the discharge at the outfall.

Analysis

Comparison of NFIC-Cincinnati, State, and Company Data

The analytical results in concentrations are shown in Table 2. which gives the values from EPA, the State, and the Company laboratories. Most values show reasonable agreement, but the BOD's, phenol, and oil and grease show some marked differences among the analyses by the three laboratories. BOD differences are attributed to the different seeds used. The State and Company used an acclimated seed, while NFIC-Cincinnati used downstream river water. The reasons for the phenol and oil and grease differences

Table 2

FMC ORGANIC - NITRO, WEST VIRGINIA, PLANT
Analytical Results - 2/16/72 - 24-hr. Composite Samples

Sample Point[1]		1			2			3			5		
		WTP Inlet			WTP Discharge			Total Waste Outfall			Raw River Water		
		EPA	W.Va.	Co.	EPA	W.Va.	Co.	EPA	W.Va.	Co.	EPA	W.Va.	Co.
Flow	MGD						0.06			3.6			
BOD_5	mg/l	2790	1890	698	2930	1650	975	164	113	93	16.5	3.1	1.
BOD_{20}	"	-		1575	-		1325	224		123	-		-
COD	"	5480	6072	7000	5360	5565	4640	277	275	304	13	< 4	16
TOC	"	1140	2000		1290		1775	29		45	8		9
pH		-	6.9	6.8	-	7.7	6.8	-	2.4	2.2	-	7.2	7.1
Tot. Solids	mg/l	10600	10988	10757	9670	9204	9126	764	457	418	408	156	-
Sus. Solids	"	113	287	210	224	673	680	66	34	68	32	36	30
TKN	"	88	6.7		62	99		-	1.8		-	0.33	
NH_3-N	"	2.1	1.1		100	79		<0.5	1.2		< 0.5	< 0.06	
Nitrite & Nitrate	"	0.6		0.46	0.7		0.17	0.4		0.36	0.3		0.46
Tot. Phosphorus	"	74			63			2.6			< 0.1		
Chloride	"	-	6000	5319	-	5600	4219	340	400	425	315	19	30
Sulfate	"	-			-			-			-		
Oil & Grease	"	980	758	386	560	1323	410	21	45	2.0	< 1	3.2	19.2
Phenols	"	660	5309	780	630	5563	750	14	98.9	14	0.05	612	0.008
Cyanide	"	<0.01	< 0.26	0.0066	< 0.01	< 0.26	< 0.001	< .01	< 0.26	< 0.001	< 0.01	< 0.26	0.006
Arsenic (2)	ug/l	-	< 0.02		-	0.03		-	< 0.02		-	< 0.02	
Lead(3)	mg/l	-	0.10	< 0.02	-	0.18	0.02	-	0.010	< 0.02	-	0.025	< 0.02
Zinc(3)	"	-	0.31	0.34	-	0.39	0.39	-	0.20	0.21	-	0.15	0.14
Aluminum(3)	"	-	1.8	4.0	-	5.1	6.88	-	1.8	1.40	-	0.4	1.28
Cadmium (3)	"	-	1.4	< 0.005	-	2.4	< 0.005	-	4.2	0.007	-	1.4	< 0.005
Chromium (3)	"	0.18	0.2	0.153	0.19	0.1	0.190	0.06	< 0.1	0.064	-	< 0.1	0.009
Copper (3)	"	0.13	0.12	0.032	0.13	0.12	0.063	-	< 0.1	0.013	-	0.1	0.01
Iron (3)	"	-	0.15	0.25	-	1.6	1.84	-	1.1	2.07	-	0.9	1.91
Magnesium(3)	"	-	2.9	2.46	-	3.6	3.03	-	4.9	4.68	-	4.3	4.68
Manganese(3)	"	-	0.16	0.18	-	0.33	0.35	-	0.12	0.11	-	0.10	0.10
Nickel (3)	"	-	< 0.1	0.055	-	0.1	0.104	-	< 0.1	0.025	-	< 0.1	0.012
Bioassay TL_m	24-hr	-			-			13			-		
	48-hr							13					
	96-hr.							13					

---

[1] Sample point No. 4, Nitro City Water, was cancelled because it was sampled under the Monsanto investigation in Nitro.

(2) Arsenic analysis not run by NFIC-Cinti.

(3) NFIC metals analyses results are below detectable or normal reporting limits except as shown.

were not determined. The findings of this study, however, are not dependent upon a resolution of any differences in analyses.

Table 3 shows the data for selected parameters of the survey converted to net pollutants loads in pounds per day.

Confirmation of Reported Data

The results of the February 16, 1973, survey did not generally confirm earlier reported data to the State by FMC-Organic, as a comparison of the values of Table 3 and Figure 3 for BOD_5 will show. The reason for the significantly higher BOD_5 during the survey has not been determined. The survey result for phenol, 418 pounds per day, is higher than the usual data reported monthly, but is in line with the 418 pounds per day average reported for the same month.

Toxicity of Effluents

Fish bioassays on the combined plant wastewater were performed at pH range of 2.6 - 5.8, DO 4.5 - 9.3 mg/l, and at 23° - 27°C. The results indicated a TL_m of 13 percent at 24, 48, and 96 hours. This is a high relative toxicity.

If the toxicity is in the WWTP, it is considerably diluted. The WTP flow of .060 MGD is mixed with 3.6 MGD of cooling water, a 60 to 1 dilution. The 13 percent TL_m was measured in the combined effluent stream and shows a strong sources of toxicity coming from the plant's liquid wastes.

TABLE 3

POLLUTANT LOADINGS
FMC Organic Chemicals Division

Outfall/ RAPP No.	Flow MGD	LOAD IN POUNDS PER DAY					
		EPA	WVA	CO	EPA	WVA	CO
		BOD_5			BOD_{20}		
WWTP Inlet	0.06	1389	945	349	-	-	789
WWTP Disch.	0.06	1459	825	488	-	-	663
Total Waste Outfall	3.6	4431	3301	2764	6729	-	3695
		COD			TOC		
WWTP Inlet		2737	3040	3479	567	977	-
WWTP Disch.		2677	2786	2315	642	-	884
Total Waste Outfall		7931	8261	8652	631	-	1081
		TS			SS		
WWTP Inlet		5103	5424	5182	41	126	90
WWTP Disch.		4538	4530	4570	96	319	325
Total Waste Outfall		10694	9042	12557	1021	60	1142
		TKN			NH_3-N		
WWTP Inlet		44	3.2	-	1.1	0.55	-
WWTP Disch.		31	49	-	50	40	-
Total Waste Outfall		-	44	-	-	36	-
		PHENOL			OIL & GREASE		
WWTP Inlet		330	2352	391	491	378	184
WWTP Disch.		315	2479	376	280	661	196
Total Waste Outfall		419	-	420	631	1256	-

Anomalies

The outstanding irregularity noted from the survey was the high BOD_5 load in the combined discharge. Following are the figures for comparison:

BOD_5 load for survey (EPA)	4,431 pounds per day
BOD_5 load for survey (State)	3,301 pounds per day
BOD_5 load for survey (FMC)	2,764 pounds per day
February, 1972, average value reported to State	1,014 pounds per day
State Phase II limit	2,100 pounds per day

As indicated previously, the EPA BOD_5 survey value may be too high because of the seed used. Nevertheless, an unusually high BOD_5 load is evident for the day of the survey.

CONCLUSIONS

1. High phenol discharges continue to be a problem at the FMC Corporation's Nitro Plant. The State Phase II and III requirements are a maximum of 16 pounds per day; recent levels are averaging more than ten times that amount. The situation is getting worse rather than improving.
2. The pH of the discharged wastewater is too low, despite acid recovery efforts by the Company. The pH ranged from 2.0 to 2.4 (1972), not a significant improvement over the past few years.
3. Performance of the waste treatment could not be appraised on the basis of the 24-hour sample because of the analyses in question and because of the extneded retention time of the lagoon.

4. The pollution abatement efforts of the FMC-Organic Chemical Division plant over the past five years have resulted in significant overall reductions in the BOD_5 loads to the river. Other than the required reduction of phenols and the low pH of the discharge, the Company appears to be meeting current state requirements on an average basis.
5. Future use criteria for the Kanawha River, however, will require reductions in pollutants.
6. The strong toxicity present in the outfall is of considerable concern. The impact of this toxicity on the receiving water and the possible effect on WWTP performance are definite problems to be solved.

RECOMMENDATIONS

1. It is recommended that a BOD_5 discharge limit of 240 pounds per day be achieved by December 31, 1975. This is based on the approved future use criteria which indicates a required dissolved oxygen for the Kanawha River of 4.0 mg/l DO at 25°C and a seven-day once-in-ten-year low flow of 1930 cfs.
2. A determination of the exact nature of the toxicity indicated from the fish bioassay is recommended, with follow up for isolation and elimination at the source.
3. Extended and higher priority efforts to meet the 16 pounds per day state limit for phenol are recommended.

4. It is recommended that the required facilities and processes be provided for adequate neutralization of the acid wastewaters. pH of the discharge should be in the 6.0 to 8.5 range to meet anticipated efluent criteria.

5. FMC should make a determination of what portion of the loads to the river is from untreated wastewaters, and report tthe findings to regulatory authorities. Further efforts at waste segregation and routing to the water treatment plant are desirable.

✓

KANAWHA RIVER
INVESTIGATION OF WATER QUALITY
AND
WATER POLLUTION CONTROL PRACTICES

VOLUME II

REPORTS OF INDUSTRIAL INVESTIGATIONS
ON SEVEN INDUSTRIES

G. Monsanto Company
Organic Chemicals Division
Nitro, West Virginia

G

United States Environmental Protection Agency
Office of Enforcement and General Counsel
National Field Investigations Center - Cincinnati
and
Region III - Philadelphia
July, 1973

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MONSANTO COMPANY

ORGANIC CHEMICALS DIVISION

NITRO, WEST VIRGINIA

GENERAL PLANT DESCRIPTION

The Monsanto Plant is located on the right side of the Kanawha River about a mile downstream from Nitro and about six miles downstream from Charleston. The Monsanto property has a river frontage of about a mile of which approximately 1,700 feet is occupied by the plant. The total plant covers 224 acres. At present, 67 acres are used for production facilities, 35 acres for the waste treatment plant, and another 35 acres for a landfill. The remaining land may be used for future expansion. Figure 1 indicates the general land use.

Operation of the plant was initiated by the first owner, Rubber Services Laboratories, in 1922. Monsanto purchased the plant in 1929, and employed 240 persons during the first year of operations. They now employ 650 persons.

The plant produced approximately 318,000,000 pounds of organic chemicals in 1971, the highest in its history. The

G-2

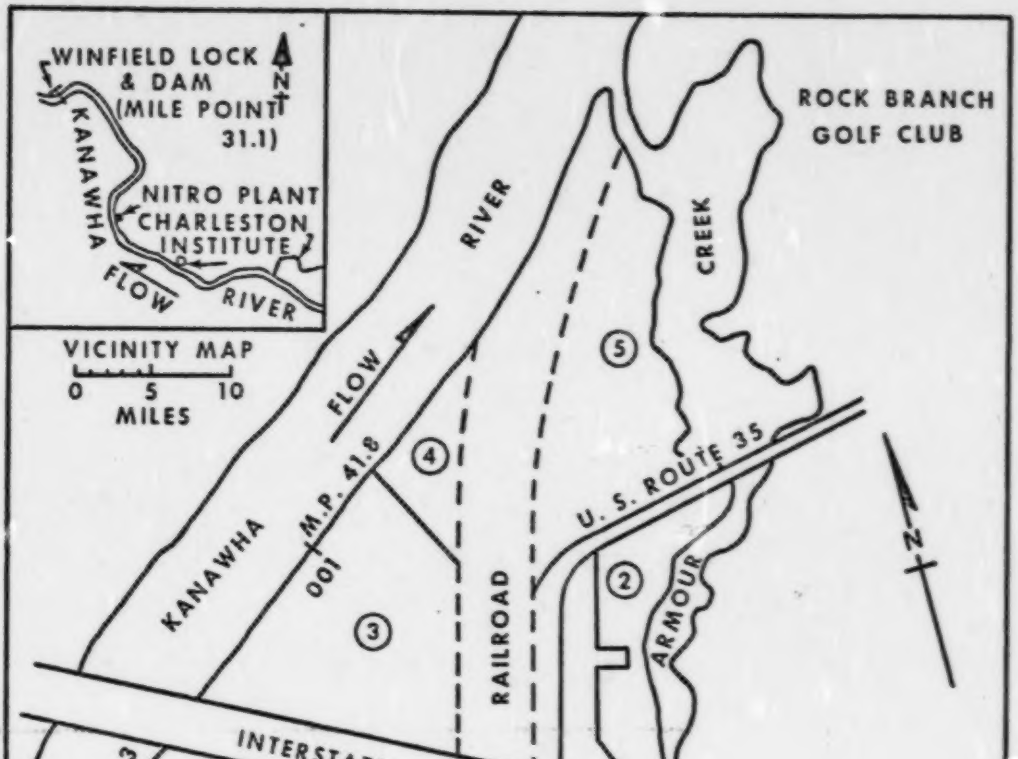
WINFIELD LOCK & DAM (MILE POINT 31.1)
N
KANAWHA
NITRO PLANT
CHARLESTON
INSTITUTE
FLOW
RIVER
VICINITY MAP
0 5 10
MILES
ROCK BRANCH GOLF CLUB
RIVER
CREEK
5
FLOW
M.P. 41.8
4
U. S. ROUTE 35
N
KANAWHA
001
3
RAILROAD
2
ARMOUR
INTERSTATE
ROUTE
64
M.P. 42.3
004
2
MILE POINT 42.6
M.P. 42.5
002
003
1
25
LEGEND
① PRODUCTION FACILITIES.
② UNIMPROVED PROPERTY.
③ WASTEWATER TREATMENT FACILITIES.
④ CITY OF NITRO'S WASTEWATER TREATMENT FACILITIES.
⑤ LANDFILL.
001 LOCATION OF OUTFALL NUMBER 001.
PENN CENTRAL
STATE ROUTE
FMC - CORP. ORGANIC CHEMICAL DIV.
FMC CORP. AMERICAN VISCOSE DIV.

FIGURE 1
MONSANTO - NITRO PLANT
GENERAL PLAN - FACILITIES AND OUTFALLS
JULY, 1972

proprietary names of the chemicals produced are listed in Table 1. Represented are rubber chemicals (accelerators, antioxidants, intermediates, and vulcanizing agents), agricultural chemicals, oil additives, plasticizers and paper chemicals. These organic chemicals are produced in 25 production units, many of which manufacture more than one product. Twenty of the units are likely to be operating at any given time.

Production operations include distillation, drying, mixing, extracting, absorption, crystallization, adsorption, sizing, filtration, evaporation, and many others. The plant operates continuously. There are no significant seasonal changes in operations, but there are variations with product demand and raw material supply. Table 2 lists the more than 100 raw materials used at the plant.

WATER USAGE

The water used in 1971 by Monsanto at the Nitro Plant is presented in Table 3. The company indicated no definite trend in water usage for the past ten years.

TABLE 3

WATER USAGE

Kanawha River water was used as follows in 1971:

Tall oil barometric condenser water	6.55 mgd
Cooling Water	2.9 mgd
Total River Water	9.45 mgd

TABLE 1

PRODUCTS OF THE MONSANTO NITRO, WEST VIRGINIA, PLANT

A-32
A-100
Avadex BW Tech
Avadex BW-UK
Avadex BW-US & Fargo
Avadex Tech
Avadex UK
Avadex US
Calcium MHA
DTO HV
DTO SHV
EL-Sixty
EM-Tall 906
EM-Tall 926
Flectol H
M-530
MBT
Mersize 70 TFL
Mersize 77T
Mersize 77 TFL
Mersize 80 TFL
Mersize 100 TFL
MHA Acid
NS-PVI
PA-1260
PC-1244
PC-1344
Rosin
RD-18-500
Mersize 603
Mersize-603-A
RT-28-A
RT-52-A
RT-53-A
FT-64-A
RT-252
Santocure 26
Santocure MOR
Santocure MOR-90
Santocure NS-Pellets
Santocure NS-Powder
Santocure Pellets
Santocure Powder
Santoflex 503A
Santoflex A-85
Santoflex AW
Santoflex DD
Santoflex DDS
Santogard
Santolene
Santolene C
Santolene CM
Santolene CP
Santolene CX
Santolube 70
Santolube 70-A
Santonox R
Santopoid 22 RI
Santopoid 22 RIA
Santopoid RI
Santopoid 23 RIA
Santopoid 33
Santopoid 35
Santopoid 39 MI
Santopoid S
Santopoid SJ
Santopoid SL
Santoquin
Santosize 70
Santosize 70T
Santovar A
Santovar AX
Santowhite Crystals
Santowhite Powder
Santowhite MK
SFA
Sodium MBT-22%
Sodium MBT-50%
Stabilized Vegadex Tech

Sulfasan R
Tetra
Thimore
Thiofide
Thitax AP
TORA
UFA Bleached
Vegadex
Vegadex Tech
Vegadex Tech

TABLE 2

Principal Raw Materials of the Monsanto Nitro, West Virginia, Plant

Acetaldehyde
Acetic Acid, Glacial
Acrolein
Acrylate, 2-Ethyl Hexyl
Agrimul A-100
Agrimul N-100
Alcohol, Butyl
Alcohol, Ethyl SDA-2B Anhyd
Alcohol, Isobutyl
Alcohol, Isopropyl
Alcohol, Oleyl. & Cetyl (Ocenol)
Alkane 56
Aluminum Chloride
Ammonia, Anhydrous
Ammonia, Aqua
Ammonium, Thiocyanate
Aniline Oil
Benzene
Butyraldehyde
Butyric Acid
Calcium Chloride
Microcel E
Carbon Bisulfide
Carbon Black No. 100
Caustic Soda, Flake
Caustic Soda, Liquid 50%
Caustic Soda, Liquid 72%
Chlorine
Clay, Attapulgus
Clay, Super Filtrol
Clenzolene
Decyl Benzene
Dibutyl Para Cresol
Dichloro Ethyl Ether
Santocel C
Dichloro Propene
Diethylamine
Diisobutylene
Diisopropylamine
Diphenylamine
Dowtherm
Dimer Acid
Cellosolve
Ethylene Dichloride
Ethylene Glycol
Dicalite 4200
Hydrogen Cyanide
Hydrogen Peroxide
Hydroquinone
Kerosene
Lime
Malic Acid Tech
Methyl Mercaptan
Monochlorobenzene
Morpholine
Muriatic Acid 20 deg
Muriatic Acid 22 deg
Naptha Hy Arom
Nitrogen
Oil, Creosote
Fuel Oil No. 2
Oil, Process
Oil, White
Oleic Acid
Paraformaldehyde
75% Phosphoric Acid
Phthalic Anhydride
Potassium Chloride
Pyridine, Refined
Liquid Crystal Wax
Rosin
Crude Tall Oil
Soda Ash
Sodium Bicarbonate
Sodium Chloride
Skellysolve C
Stearic Acid
Sterox SK
Molten Sulfur
Sulfur Monochloride
Sulfuric Acid 93%
Sulfuric Acid 100%
Tertiary Amylene
Toluene
1,2,3 Trichloro 1-Propene
Trichloroethylene
Triethylene Tetramine
Urea
Xylene
Tricresyl Phosphate
Toluene Sulfonic Acid
Fumaric Acid
Benzol
Santobrite
Cyclohexylamine
Dodecyl Aniline
Para Phenetidine
Caustic Potash
Sodium Sulfite
Acetone
Methanol
50% Formalin
Disodium Phosphate
Sterox CD
Varsol 27

Table 3 (Continued)

All other water used in 1971 was purchased from the West Virginia Water Company (Nitro City Water):

Boiler Feed	0.690 mgd
Cooling (Make Up)	0.147 mgd
Sanitary	0.060 mgd
Process	1.250 mgd
Total Purchased Water	2.147 mgd

WASTEWATER DISCHARGES AND WASTE SOURCES

The Monsanto Company has four outfalls to the Kanawha River two of which are active (the treatment plant and the tall oil process and cooling water). The tall oil process barometric condenser wastewater, which is combined with a cooling water stream, discharges to the Kanawha River. All other wastewater from the plant, including storm sewer waters, flows to a lift station and is pumped to a wastewater treatment plant located approximately one-half mile downstream from the plant. Table 4 is a tabulation of discharges and waste sources.

TABLE 4

No.	Description of Outfall	Milepoint	Flow MGD
001	Treatment Plant	41.8	1.712
002	Tall Oil Process and Cooling Water	42.5	7.92
003	(Old No. 1) Inactive (Emergency Overflow)	42.6	-
004	(Old No. 2) Inactive (Emergency Overflow)	42.3	-

WASTE TREATMENT PROGRAM

Historical Development

The plant began extensive pollution abatement work in 1958 when Phase I of the West Virginia Department of Natural Resources started the phased program for clean-up of the Kanawha River. The Monsanto requirements for the three phases, starting with a base load of 16,420 pounds BOD_5 per day to the river, are shown in Table 5.

TABLE 5

West Virginia Phased Program for Monsanto Plant at Nitro

	% Reduction from Base	BOD_5 Discharge Limit	Compliance Date
Phase I	40	9,850 pounds per day	6/30/73
Phase II	70	5,000 pounds per day	6/30/66
Phase III	86	2,500 pounds per day	12/31/72

The Phase II limits apply for the period of this study. A check of recent State records and calculations from monthly average shows improvement but some difficulty in meeting the 5,000 pounds BOD_5 per day limit.

1968	5,900 pounds BOD_5 per day average Averages exceeded 5,000 pounds per day limit for 8 months
1969	5,600 pounds per day average Averages exceeded 5,000 pounds per day limit for 7 months
1970	5,900 pounds per day average Averages exceeded 5,000 pounds per day limit for 8 months
1971	3,600 pounds per day average Averages exceeded 5,000 pounds per day limit for 2 months
1972 (5 mos.)	4,088 pounds per day average Averages exceeded 5,000 pounds per day limit for one month

The waste treatment system development started in the early 1960's. Flow meters and samplers were installed on all outfalls. Large scale pilot plants were constructed to check out standard biological treatment processes and certain variations of them. Activated sludge did not perform well because of settling problems. The aerated lagoon system showed promise, was checked further, and selected for the full scale plant. An outline of the construction schedule follows:

Primary lagoon and interceptor completion	June, 1963
Neutralization pit and first aerated lagoon completion	Oct., 1963
Second aerated lagoon completion	May, 1966
Aeration capacity increase (2x) completion	Apr., 1970

Process wasteloads were reduced by in-plant methods, and activated sludge was again checked by lab studies. The aerated lagoon provided better average removals, as in the earlier comparisons with the activated sludge process. The BOD_5, BOD_{20}, and total Kjeldahl nitrogen loads per day for recent years are shown respectively in Figures 2, 3, and 4. The evident decline of biochemical oxygen demand loadings was broken for a period of several months starting in October of 1971. An upset in the wastewater treatment platn (WWTP) was caused by a minor change made in a process to improve efficiency. This change had an unexpected side reaction which produced a member of the sulfa drug family in trace quantities, but sufficient for the antibiotic to cause the major upset in the biological treat-

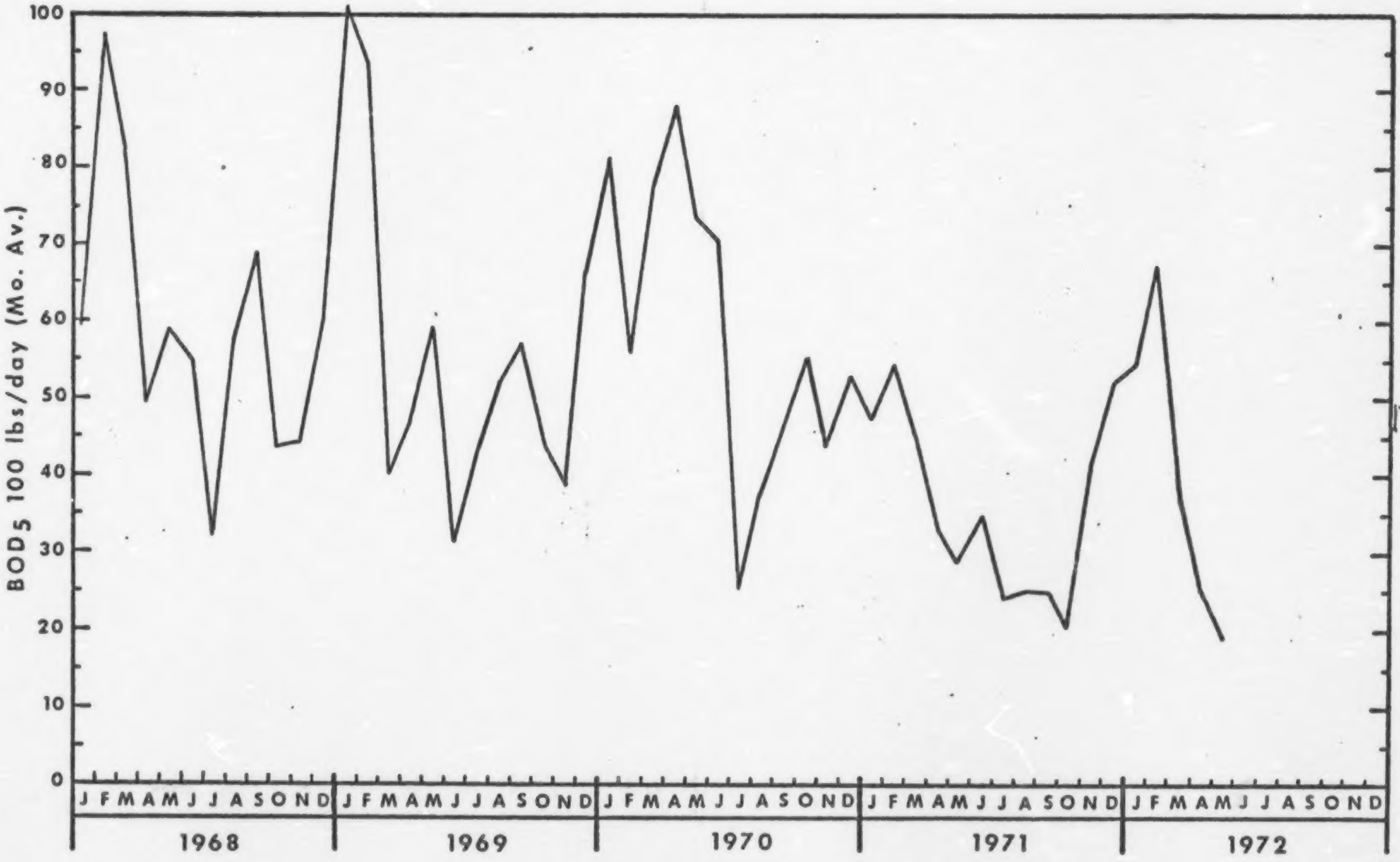

FIGURE 2

MONSANTO NITRO, W. VA. PLANT TOTAL BOD_5 LOAD PER DAY TO KANAWHA RIVER

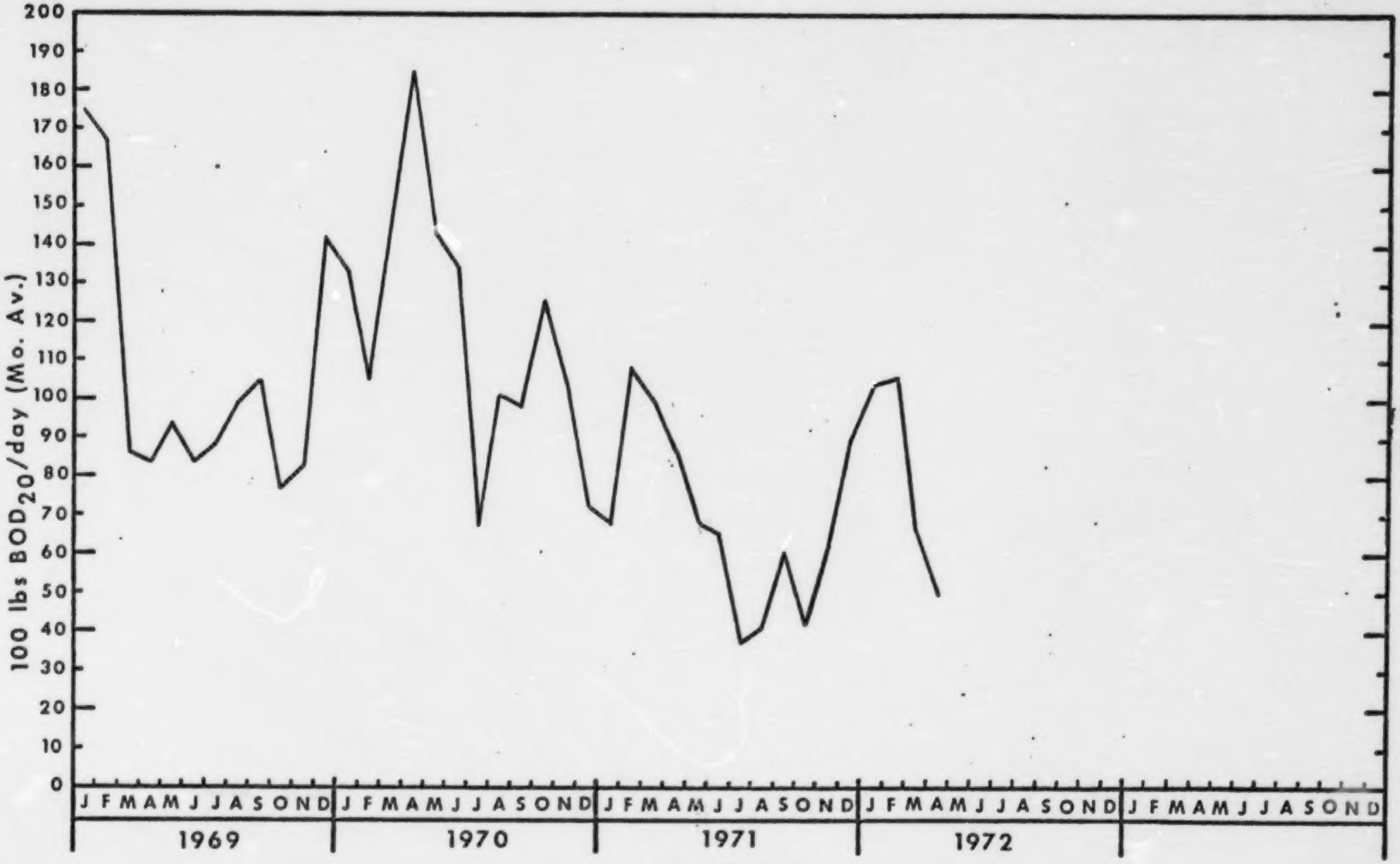

FIGURE 3

MONSANTO NITRO, W. VA. PLANT TOTAL BOD_{20} LOAD PER DAY TO KANAWHA RIVER

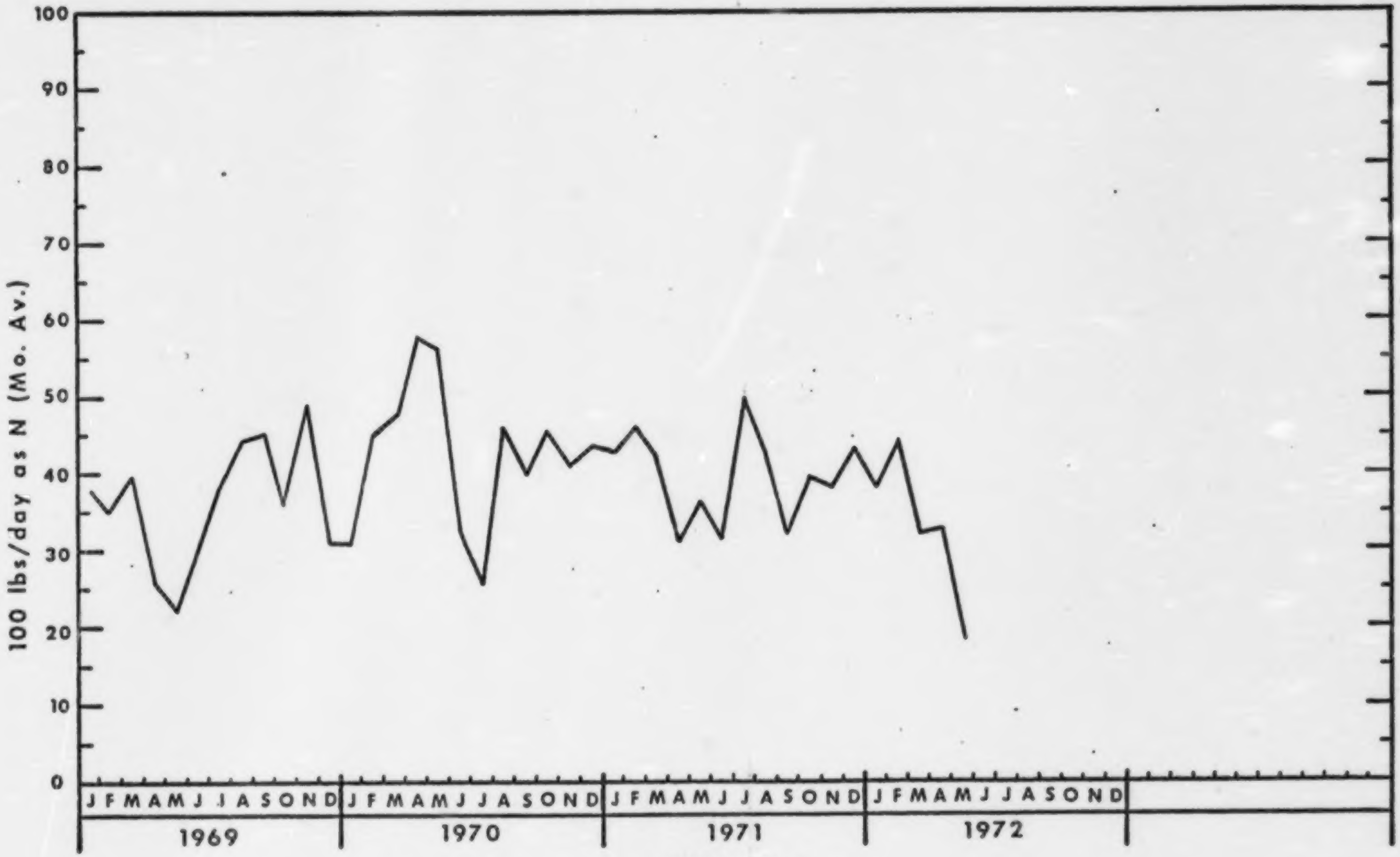

FIGURE 4

MONSANTO NITRO, W. VA.

PLANT TOTAL KJELDAHL NITROGEN LOAD PER DAY TO KANAWHA RIVER ment system. As the graphs show, the problem has been corrected. The decline in loadings has been achieved during times of marked increases in production and is especially noteworthy in that regard. Figures 5 and 6, provided by the company, show this contrast in production levels and effluent loads and the declining effluent loading per unit of production.

Existing Waste Treatment Facilities

Incineration and Landfill

For the year 1971, Monsanto reported 8,782 pounds per day TOC disposed of by landfill and 18,940 pounds per day TOC by incineration. On the basis of all waste loads reported as TOC, landfill and incineration disposal represents approximately 57 percent of the total. Table 6 represents the data reported by the company except that their numbers for by-product sale, waste load reductions through monitoring, etc., and material recycled to process have been deleted as inappropriate in a rechurning of the actual total plant waste load.

TABLE 6

Disposition of the Total Waste Load - Monsanto Plant

	Pounds Per Day Total Organic Carbon
Material landfilled	8,782
Material burned	18,940
Material to disposal pond	9,372
Material to treatment plant (value low as sampling misses solids and oils)	8,102
Tall Oil barometric condenser uncontrolled load (1962 level)	3,207
TOTAL LOAD	48,403

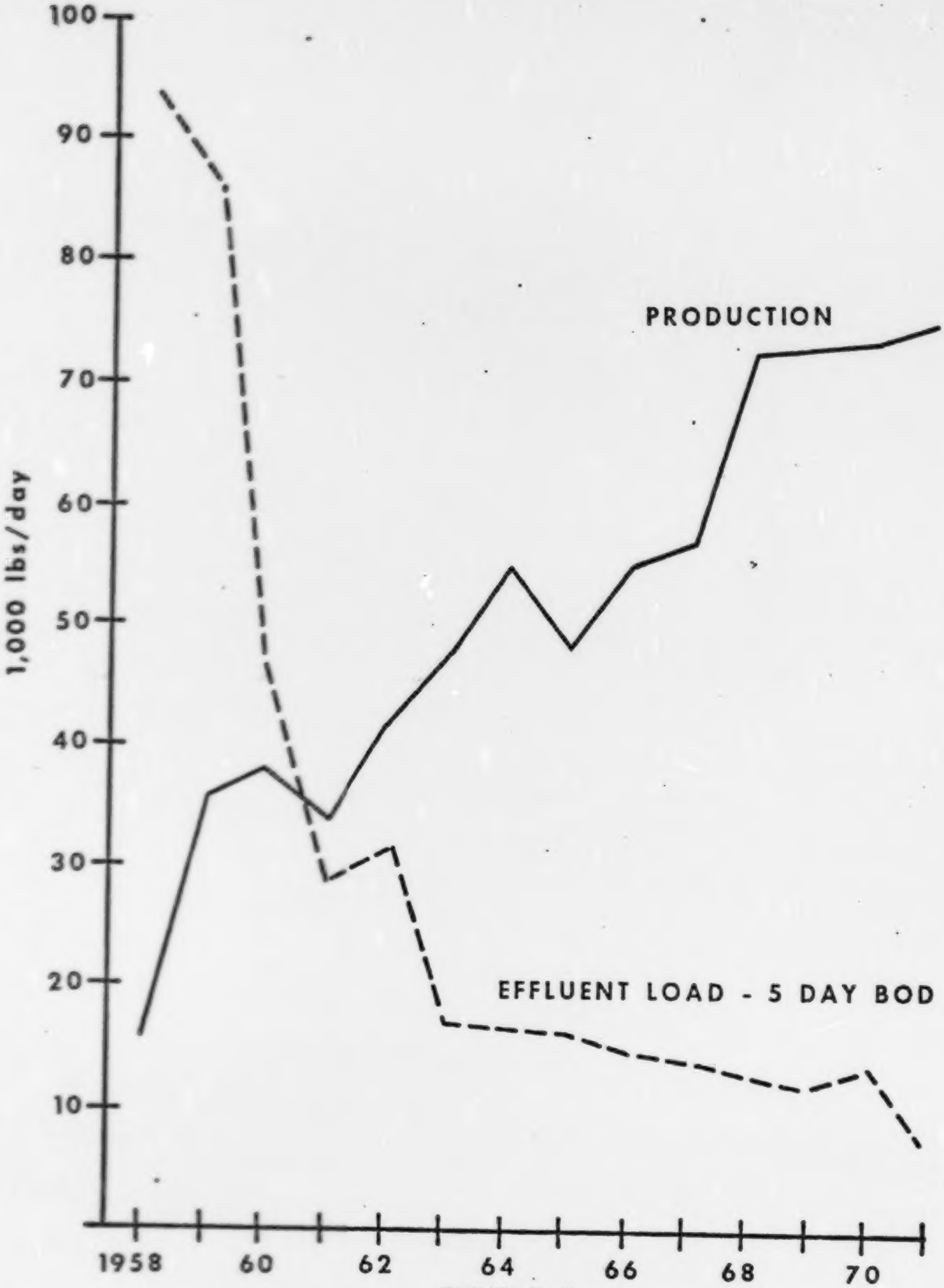

FIGURE 5
EFFLUENT LOAD REDUCTION AND PRODUCTION INCREASE
MONSANTO NITRO, WEST VIRGINIA PLANT

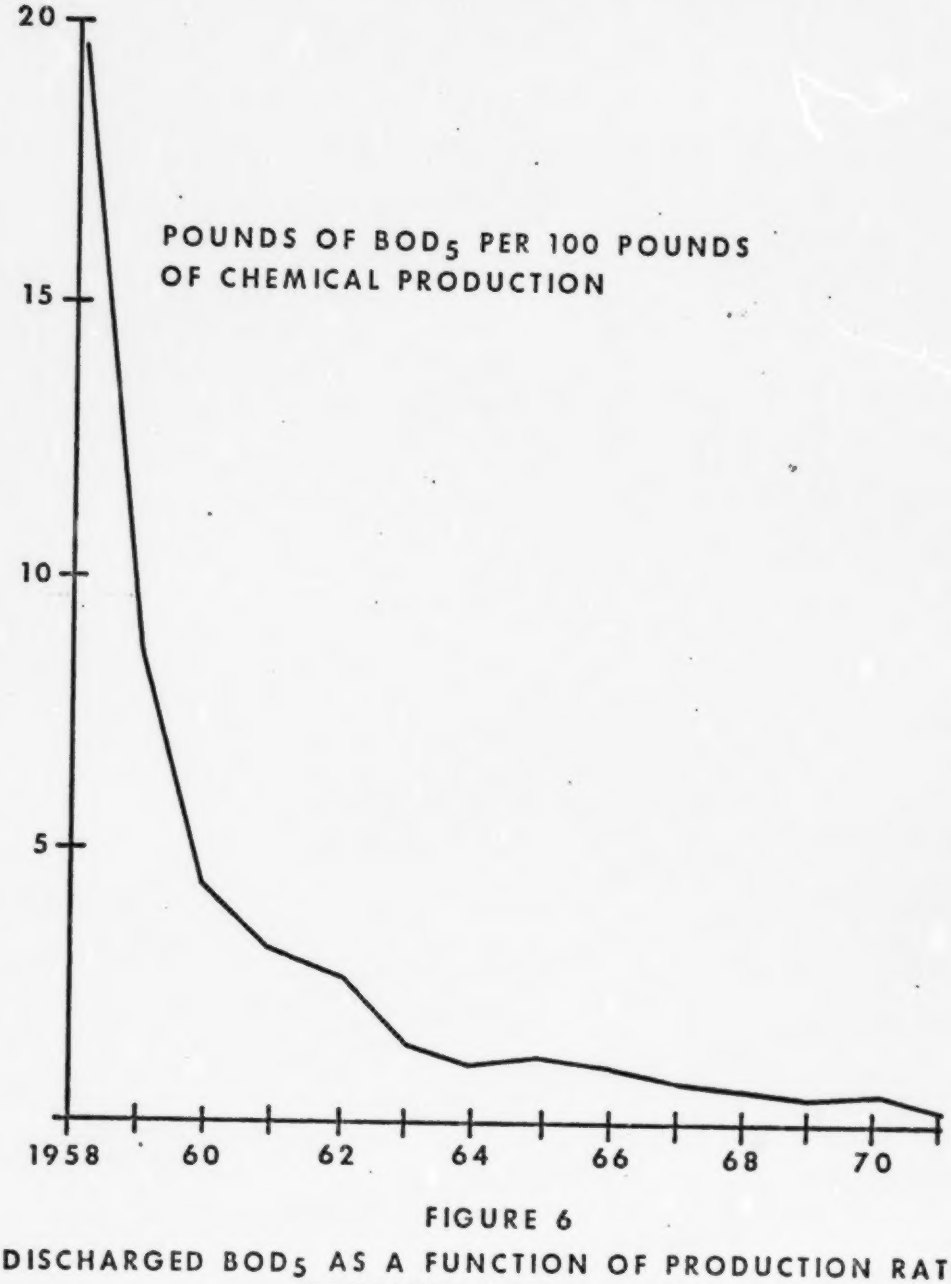

FIGURE 6

DISCHARGED BOD$_5$ AS A FUNCTION OF PRODUCTION RATES
MONSANTO NITRO, W. VA.

Wastewater Disposal

Wastewater Treatment Plant Description

The description under this section covers the WWTP existing at the time of the 1972 survey and is shown in Figure 7.

With the exception of the tall oil process barometric condenser wastewater, which is discharged with a cooling water stream, all wastes are sewered and processed through the WWTP.

Primary treatment is provided by three large lagoons. The first serves as a pump sump after the gravity interceptor from the production area. The second and third (four to five and two days retention time, respectively) provide for removal of settleable solids and floating material, as well as equalization and storage capacity. A spill or upset can be segregated in the largest lagoon and slowly blended into the main flow. pH adjustment is provided by flow through a 5,000-ton crushed limestone bed. This provides, the Company reports, reliable control without the problems of instrumentation and metering pumps.

Secondary treatment is provided by two aerated lagoons of 1.2 million gallons capacity each. Aeration is provided by one fixed Infilco 50 horsepower turbine aerator (rated capacity 5,000 pounds per day oxygen transfer) and three Lightnin floating aerators (rated capacity of each 3,900 pounds per day oxygen transfer). These aerated lagoons were originally designed to

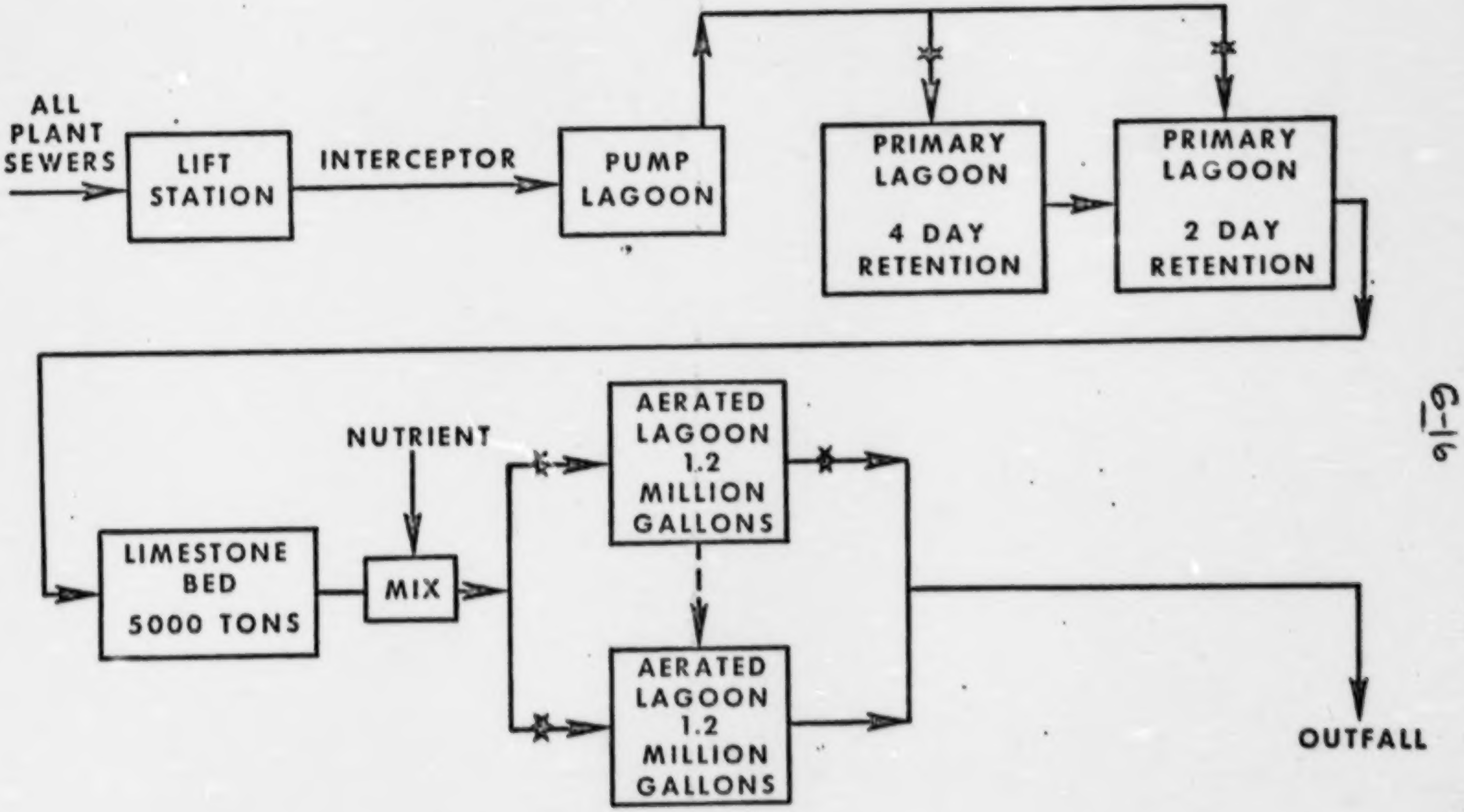
ALL PLANT SEWERS
LIFT STATION
INTERCEPTOR
PUMP LAGOON
PRIMARY LAGOON 4 DAY RETENTION
PRIMARY LAGOON 2 DAY RETENTION
LIMESTONE BED 5000 TONS
NUTRIENT
MIX
AERATED LAGOON 1.2 MILLION GALLONS
AERATED LAGOON 1.2 MILLION GALLONS
OUTFALL

FIGURE 7
WASTE TREATMENT PLANT
MONSANTO NITRO, W. VA. PLANT
MARCH 1972

be operated in parallel, but have been operated experimentally in series-parallel (all flow from one lagoon discharging into the second, both lagoons receiving equal amounts of primary effluent) to obtain increased efficiency.

The capacity of the treatment plant is as follows:

a. Primary treatment-visual pollution removal - above 5.8 mgd.

b. Primary treatment-solids and oil removal plus full equalization - 4.5 mgd.

c. Limestone bed and biological treatment - 2.6 mgd maximum.

Cooling Water

All plant cooling water is discharged through Outfall No. 002. This stream also contains the tall oil process barometric condenser wastewater, as mentioned previously. The cooling water discharge represents a significant portion of the total BOD_5 load Monsanto discharges to the river, as can be seen from the data of Table 10. The stream was untreated at the time of the March, 1972, survey. A new waste treatment pond for removal of fatty acids was completed in August, 1972.

Monitoring

In-plant monitoring is provided by means of continuous samples at the manufacturing plant, the wastewater lift stations, and the tall oil intake and discharge. TOC analyses, supplemented by GLC analyses, are performed daily. A continuous hot wire instrument coupled with an alarm and recorder is used to detect volatile solvents in the sewer. Continuous on-stream TOC analyzers have been installed at the three most significant sources.

At the treatment plant, flow is measured and recorded by magnetic flow meters. TOC and pH are analyzed daily, and other parameters weekly on composite samples. These are BOD_5, BOD_{20}, total solids, suspended solids, settleable solids, Kjeldahl nitrogen, acidity, and chloride.

Removals and Efficiency

The company reports that only a limited amount of data have been collected on overall treatment plant efficiency. Their emphasis has been on monitoring soluble organics, as they feel that suspended solids and oils are virtually completely removed in the primary lagoons. They have, however, recently established the BOD_5 and TOC ratio on current wastewaters and applied it to estimate raw BOD loads from 1971. The treatment plant efficiency was then estimated as shown in Table 7.

The samples taken and analyses made under this EPA survey do not provide good data for evaluating of the WWTP removals. It was necessary, because of a concurrent sampling load at nearby plants on the Kanawha, to do all the Monsanto sampling (as for other plants) during one 24 hour period. As the WWTP has about a seven-day retention time, the influent and effluent for the

TABLE 7

Monsanto Nitro, West Virginia, Plant, 197o Treatment
Plant Efficiency

	Five-Day BOD Load		
	Est. WTP Input Pounds Per day	WTP Discharge Pounds per Day	% Removal
January	12,592	3,363	73.5
February	16,301	4,324	76.1
March	15,613	4,257	79.6
April	14,933	2,189	83.2
May	22,858	2,543	86.1
June	12,477	2,458	81.7
July	9,689	2,076	76.1
August	9,923	1,832	81.4
September	12,221	2,117	82.8
October	11,705	1,544	83.6
November	12,131	3,377	71.0
December	11,947	4,094	65.7
1971 Average	13,533	2,765	78.45

24-hour period are not valid for comparison and determination of removal efficiencies.

Spill Potential

Monsanto's storage areas include one fairly large facility along the river in which acetone and crude oil are stored on receipt from barges, a separate tank farm area where organic solvents are handled, and a number of storage tanks adjacent to process areas where the material is used.

At the river there are two separate receiving stations. Barges are tied to piles. The pumping station for unloading materials is located on shore and connection is made to the barge with flexible pressure hose. The hose is inspected and pressure-tested on a regular schedule and the date of latest inspection is stencilled on the hose. One of the two receiving stations handles acetone which is pumped to a 500,000 gallon tank on the river bank enclosed in a large earthen dike. The second receiving station handles tall oil which is pumped to three 500,000 gallon tanks and a variety of product and intermediate organic materials which are stored in four 300,000 gallon aluminum tanks. This tank farm follows the standard Monsanto practice for diking.

Monsanto handles and stores carbon disulfide. This material is received by pipeline from the adjacent FMC plant. In many plants the standard for carbon disulfide is to keep the storage tanks completely immersed in a diked area in water. Any spill or leakage of carbon disulfide in such a system must drain to a low point in the water pool from which it can be recovered by a sump pump. Monsanto's installation is new and follows a different design philosophy. The tank is enclosed in a dike and provision is made for water flooding if necessary. Since the diked area is normally empty, any spill can be quickly detected and handled. In the storage tank proper, Monsanto follows the usual practice of maintaining the tank full of water above the carbon disulfide level. When the tank is filled, water is displaced through a separator and flows to the process sewer. When the tank is emptied, water is automatically admitted to maintain the tank full and at atmospheric pressure. It is necessary to use thermostatic temperature control to prevent freezing of this sealed water in the tank and in the transfer lines. The dike around the carbon disulfide tank is of reinforced concrete design.

HCN is obtained from the Belle plant of DuPont by railroad tank car. When the car is shipped, DuPont notifies Monsanto and any delay in the 60 mile transfer down the river can be investigated immediately. A carefully worked out plan of notification and emergency action is in force in the event of any emergency during shipment of the car between the two plants. At the Monsanto plant the tank car is spotted in an exact location at the unloading position. The car is of special design, including roller bearing trucks so that easy movement without shock can be effected. Connection from the tank car to Monsanto's unloading pump is made by a solid stainless-steel pipeline; no flexible joints are used. The pipe is pickled with acid and washed before installation and then pressure tested to 40 psi with nitrogen. Nitrogen at 10 psi is then used to force unload the car to Monsanto's storage tank. Monsanto's storage tank is a refrigerated tank with special provision for monitoring leaks of HCN gas. A pressure control system maintains 2 psi of nitrogen on the storage tank and the vent is through a flare. A pilot light burns constantly at the top of the flare so that any HCN in the vent gas is automatically destroyed. All connections to the storage tank, as well as to the box car, are at the top of the tank. There are no bottom connections of any kind. HCN is soluble in water and there is a deluge system fitted to the storage tank as well as to the tank car area for immediate flooding of any leak with water.

Monsanto's practice is to build a dike around any tank containing a toxic, flammable, or water-insoluble material. Chemicals such as HCN, aniline, butyl acetate, formalin, xylene, and acrolein are diked. Inorganic reagents such as sulfuric acid are not diked. Monsanto feels that the cost of a dike for these materials is not justified, since the most likely method of disposal of a spill would be by dilution and control discharge to the river in any event. A spill would not flow directly to the river, but would be handled via the treatment plant. Carbon disulfide and HCN were cited as two dangerous materials for which special handling is required.

In addition to diking, it is Monsanto's practice to use catch basins and sumps wherever the likelihood of leakage and spill is high. The standard for fill lines to large storage tanks is evolving. Current practice is to run this line to the tank via a high loop. The line enters the top of the tank and extends to near the bottom so that during the fill there is no fall of liquid in the tank. This practice guards against vaporization of volatile materials and ignition via static charge. To prevent siphoning, Monsanto drills a small vent hole in the fill line inside the tank near the top. This design is under review because of the fear that during the fill spray of liquid through this vent hole may cause some static electricity problems. All tanks are subject to regularly scheduled inspection to determine their condition. The shell thickness is inspected by ultrasonic gaging. On tanks where corrosion is likely to be a problem, the tank is emptied, cleaned, and visually inspected.

Monsanto is a member of the KRIAC Committee and follows the practice of the several Kanawha Valley emergency and disaster control plans.

The above information was obtained from EPA's publication "Oil and Hazardous Materials Program" - "Spill Prevention Techniques for Hazardous Polluting Substances," dated February, 1971.

Monsanto has an unusual and exemplary system for minimizing the effects on the river from process spills. It was noted above under "Wastewater Discharges and Waste Sources," that all sewers, including storm sewers, flow to the WWTP, except for the tall oil and cooling water outfall. The primary lagoons provide equalization to reduce the shock of any spill on the biological treatment system. The potential pollution of the river from in-plant spills is thus considered to be minimal.

Recent Improvements and Future Plans

Monsanto recently expanded their existing wastewater treatment plant, as indicated in Figure 8, to comply with the Phase III requirements of the state. Construction started in July and was completed in December, 1972. The salient features are a five-fold increase in retention time, additional aeration capacity, and improved flexibility in operation. Construction of a new waste treatment pond for removal of fatty acids by flotation from the tall oil stream was completed in August, 1972. These improvements will provide capacity for future increased loads.

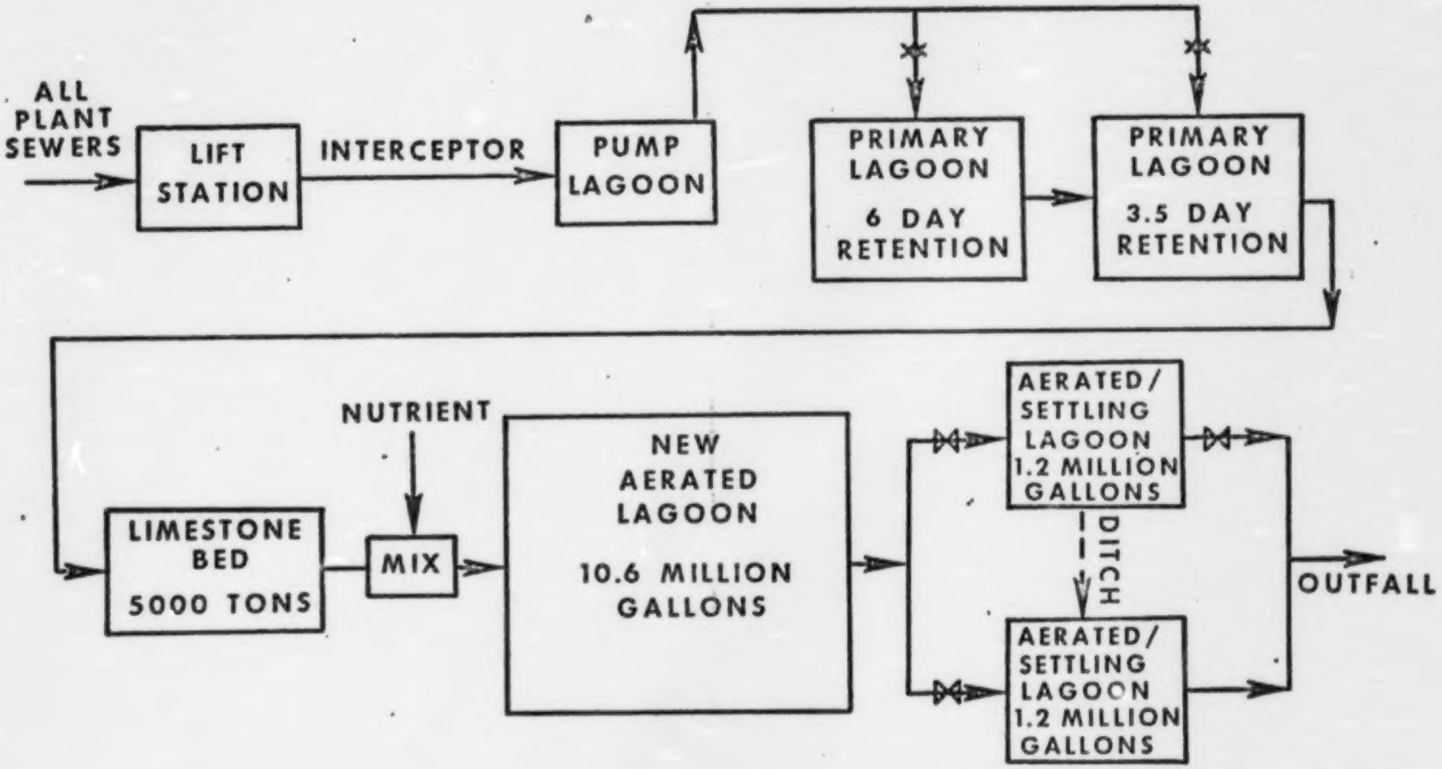
ALL PLANT SEWERS
LIFT STATION
INTERCEPTOR
PUMP LAGOON
PRIMARY LAGOON 6 DAY RETENTION
PRIMARY LAGOON 3.5 DAY RETENTION
LIMESTONE BED 5000 TONS
NUTRIENT
MIX
NEW AERATED LAGOON 10.6 MILLION GALLONS
AERATED/ SETTLING LAGOON 1.2 MILLION GALLONS
DITCH
AERATED/ SETTLING LAGOON 1.2 MILLION GALLONS
OUTFALL

FIGURE 8
MODIFICATIONS TO WASTE TREATMENT PLANT
MONSANTO NITRO W. VA. PLANT

New facilities for removal of ammonia nitrogen from the major source began operation in January, 1973. The ammonia is stripped under alkaline conditions and is incinerated.

Tall oil column demister capacity was tripled recently and cooling capacity was increased for pollution control improvements.

Research work toward a major improvement in the largest single process source (25 to 30 percent of the treatment plant load) recently passed a critical point and is reported as highly encouraging. It is anticipated that this reduction will be achieved by late 1974.

A continuing program is being carried out to review the contribution from each individual process and institute new control methods. The most recent of these studies was completed in mid-1972.

NFIC-CINCINNATI FIELD SURVEY

Sampling

The two active wastewater discharges, No. 001 (WWTP) and No. 002 (tall oil and cooling water) were sampled for a 24-hour period on February 16 and March 12, 1972. The city and Kanawha water supply sources were also sampled. Samples were taken at two hour intervals for 24-hour composites. NFIC-Cincinnati took split samples for the state; Monsanto took their own.

The second date for sampling was scheduled because the tall oil process was unexpectedly not operating on February 16, 1972. The March 21, 1972, date was scheduled to sample that process but the scope of the effort was expanded at the company's request to include the waste treatment plant. This was requested because the waste treatment plant was not considered to have been adequately recovered from the sulfa drug upset at the time of the February 16, 1972, sampling.

Analyses

Analytical results for the February 16 and March 21, 1972 sampling periods are shown in Tables 8 and 9. Table 10 shows a portion of the March 21, 1972, data converted to loads in pounds per day.

For the purposes of this survey, reasonable agreement of the data from the EPA, State, and Monsanto sources was obtained, but certain significant exceptions have been noted. The Company has stated that the BOD_5 loads for the tall oil discharge as calculated from the March 21, 1973, analyses are too high.

The NFIC-Cincinnati tall oil discharge analytical results for phenol and oil and grease have also been questioned by the company. The NFIC-Cincinnati phenol analysis for the March 21, 1973, tall

TABLE 8

ANALYTICAL RESULTS FOR 2/16/72 SAMPLING
Monsanto Nitro, West Virginia, Plant

Sample Point		1			2			3		
		WTP Inlet			WTP Discharge			City Water		
		EPA	W.VA.	CO.	EPA	W.Va.	CO.	EPA	W.VA.	CO.
Flow	mgd			2.31			2.18			
BOD_5	mg/l	2250		345	387	240	264			2.44
BOD_{20}	mg/l			300	608		270			1.6
COD	mg/l	1600	1862	2034	1080	992	1363		1	1
TOC	mg/l	450		420	240		325			40
pH							7.1		7.3	7.5
Total Solids	mg/l	6900	6300	3993	6420	6587	5081		148	146
Suspended Solids	mg/l	503	265	599	72	142	59			
Volatile Solids	mg/l									
TKN	mg/l					194	157			1.2
NH_3-N	mg/l	160	140	95	210	174	130			0.3
Nitrite & Nitrate	mg/l	1.3			0.7					
Tot. Phosphorus	mg/l		2.2	0		1.8	1		3.0	0
Chloride	mg/l		2340	2002		2540	2213		30	14
Sulfate	mg/l			1305		1700	1676		29	32
Oil & Grease	mg/l	1600	232	123	35	66	35			2.4
Phenols	mg/l	Lost (Low)		3.68	0.26		0.44		.007	0
Cyanide	mg/l	0.01		0.2	0.01					0
Mercury	µg/l	1.2								
Arsenic	µg/l									
Lead	mg/l									
Zinc	mg/l									
Aluminum	mg/l									
Cadmium	mg/l									
Chromium	mg/l				0.07					
Copper	mg/l									
Iron	mg/l									
Magnesium	mg/l									
Manganese	mg/l									
Nickel	mg/l									
Bacti		No./100 ml								
Total Coliform		100			560					
Fecal Coliform		10			10					

NOTE: Metals analyses showed values below detectable or normal reporting limits except as shown.

TABLE 9

MONSANTO NITRO W. VA. PLANT - ANALYTICAL RESULTS FOR 3/21/72 SAMPLING

Sample Point		1			2			3			4			5		
		WTP Inlet			WTP Discharge			Tall Oil Discharge			River Water			City Water		
		EPA	W.Va.	Co.	EPA	W.Va.	Co.	EPA	W.Va.	Co.	EPA	W.Va.	Co.	EPA	W.Va	Co.
Flow	MGD			2.005			1.712			7.92						
BOD_5	mg/l	327	801	411	231	217	271	39.1	52	28	3.2	3.5	11.5			2.76
BOD_{20}	"		1021	837	544	493	426 .		75	35.7		4.4	13.5			4.74
COD	"	1670		1550	1300		1094 1176	133		14.8	13		15	< 5		57.4
TOC	"	480		595	290		335	29		40	6		25	5		35
pH		2.5	2.8	2.85	6.6	6.6	6.4	5.7	5.8	6.2	6.1	6.2	6.2	7.3		7.4
Tot. Solids	mg/l	4700	4853	4540	8660	8774	8648	210	230	202	254	236	236	48		150
Sus. Solids	"	48			142		80	20		202	21		16	6		
Vol. Solids	"	818			1100		9	26		40	100			30		
TKN	"	37	174	262	220	240	267	1.0	1.3	28	0.8	1.2	3.9	0.2		2.60
NH_3-N	"	36	157	230	190	215	215	1.0	0.49	20	0.5	0.49	1.2	<0.5		0.87
Nitrite & Nitrate	"	0.8			0.4			0.8			0.9			1.1		
Tot.Phosphorus	"	5.5	4.0	7.	18.3	17	16	0.1	0.5	0	1.0	0.27	0			0
Chloride	"		3600	2540			3180	40	100	35	40	49	35			35.
Sulfate	"		1000	1075	2620		2510	68	80	111	87	80	102			78.
Oil & Grease	"	350		34.2	22		4	36		0	1		0			0
Phenols	"	1.3	0.045	1.3	0.33	0.074	0.6	2.6	0.54	0.30	0.1	0.110	0.30	<0.01		0.30
Cyanide	"	<0.01			<0.01			<0.01			<0.01					
Mercury	μg/l															
Arsenic	μg/l															
Lead	mg/l															
Zinc	"															
Aluminum	"															
Cadmium	"															
Chromium	"															
Copper	"															
Iron	"															
Manganese	"															
Magnesium	"															
Nickel	"															
Bioassay TL_m 24-hr.					10			39								
48-hr.					7.6			39								
96-hr.					7.6			39								

TABLE 10

RESULTS OF 3/21/73 SAMPLING AND ANALYSES

		LOAD IN POUNDS PER DAY					
		EPA	WVA	CO	EPA	WVA	CO
Outfall/ RAPP No.	Flow MGD	BOD_5			BOD_{20}		
WWTP Inlet	2.005	5468	13394	6825	-	17073	13917
WWTP Disch. 001	1.712	3259	3059	3830	7768	7040	6083
Tall Oil 002	7.92	2371	3203	1090	-	4663	1466
		COD			TOC		
WWTP Inlet		27925	-		7943	-	9364
WWTP Disch. 001		18564	-	15974	4070	-	4284
Tall Oil 002		7926	-	-	1519	-	991
		TS			SS		
WWTP Inlet		77790	-	72953	703	-	-
WWTP Disch. 001		122979	124607	121351	1943	-	1142
Tall Oil 002		-	-	-	-	-	-
		TKN			NH_3-N		
WWTP Inlet		615	2909	4338	602	2626	3832
WWTP Disch. 001		3142	3427	3776	2713	3072	3058
Tall Oil 002		13.2	6.6	1592	33	-	1242
		PHENOL			OIL & GREASE		
WWTP Inlet		16.7	0.7	16.7	5856	-	572
WWTP Disch. 001		4.7	1.0	4.3	3.4	-	57
Tall Oil 002		165	28	0	2379	-	0

oil wastewater sampling is much higher than those of the state and company. It should be noted, however, that the state analysis would indicate a phenol load of 28 pounds per day as compared with the state limit of 4 pounds per day. The data do not appear to be conclusive and follow-up study is indicated. The same is true of the data for the tall oil discharge oil and grease analysis.

Monsanto has stated that their tall oil effluent adds about one part per million of organic chemicals which are read as phenolics by the Standard Methods 4-aminoantipyrine test. They further state that these organics are biodegradable and do not contribute to taste and odor problems in drinking water and fish.

Toxicity of Effluents

Static bioassays were conducted on fathead minnows using wastewater from the two active outfalls from the wastewater treatment plant and the tall oil process. At least a portion of the toxicity measured at the Monsanto outfalls may have a neighboring plant, FMC Organic, as a source. The apparent toxicity of the tall oil discharge could be due entirely to that source. At the WWTP, however, the toxicity measured is significantly higher than the FMC Organic discharge and death of the test animals was immediate in 56 percent test solution.

Bioassay test conditions for the WWTP discharge were a sample pH of 6.7, DO range of 4.7 - 7.2 mg/1, pH range 6.3 - 6.5, and temperature range of 23 - 27°C. The TL_m (median tolerance limit) was 10 percent at 24 hours and 7.6 percent at 48 and 96 hours.

The TL_m or median tolerance limit is the concentration of effluent that would be lethal to 50 percent of the fish held in it for the specified time period, i.e., 24, 48, or 96 hours. Thus, the lower the TL_m, the higher the toxicity of the effluent.

For the tall oil discharge, the bioassay test conditions were a sample pH of 5.5, DO range 4.7 - 6.7, pH range 5.7 - 6.5, and temperature range 23 - 47°C. The TL_m at the FMC Organic plant discharge, about 200 yards upstream from the Monsanto intake, was 13 percent at 24, 48, and 96 hours. As a bioassay test was not made on the intake, the tall oil discharge results are inconclusive.

Anomolies

The difference between the WWTP inlet and discharge flows can be attributed to the lower accuracy of the inlet flow meter and possibly an inflow of surface water drainage.

The low input BOD_5 load to the WWTP on March 21, 1972, is attributed to the fact that a production unit which ordinarily is a large source of the load was down on that date.

The high discharge BOD_5 load on February 16, 1973, was caused by an upset from which the treatment plan had not recovered, as mentioned earlier in this report.

CONCLUSIONS

1. Pollution abatement programs at the Monsanto, Nitro, West Virginia, plant have been generally successful in reducing the pollutional load to the river during a period of large increases in production.
2. Records have shown a wide fluctuation in the BOD_5 loads discharged to the river. There is a need for more accurate measurement of WWTP performance.
3. The established future use criteria for the Kanawha River will require significant additional abatement efforts over those existing at the time of the survey. Although the recently completed WWTP expansion is expected to meet the state Phase III requirements, its ability to meet future use criteria has not been appraised.
4. A toxic discharge problem exists which requires specific corrective action.

RECOMMENDATIONS

1. It is recommended that the following discharge limits for the Monsanto Nitro, West Virginia, plant be achieved by December 31, 1975:

   BOD_5 320 pounds per day

   TKN 2,290 pounds per day

   These numbers are based on the approved future use criteria of 4 mg/l DO (25°C) and a seven-day once-in-ten-year low flow of 1930 cfs. The total for all industries is not to exceed 12,000 pounds per day BOD_5 load to the Kanawha River.

2. Eliminate toxic materials in discharges from the plant outfalls so that the 96-hour TL_m shall be no less than 100 percent. This means that a 96-hour static bioassay test using fathead minnows shall show at least 50 percent survival of these test animals in 100 percent, or undiluted, effluent solution.

3. Maintain the pH of all discharges in the 6.0 - 8.5 range.

4. Meet the State phenol discharge limit of 4 pounds per day. In this regard, it is recommended that Monsanto submit to the state and EPA documented evidence that the tall oil wastewater organics reported as phenol by Standard

Methods analysis do not in fact present a water supply taste and odor problem.

5. It is recommended that the Company establish a WWTP monitoring system which will include determination of inlet values of BOD_5, COD, TOC, and TKN. This will provide for a means for estimating removals and WWTP efficiency.

6. The possible utilization of primary lagoon facilities as an anaerobic lagoon should be consiered fur future wastewater treatment requirements. This has been successfully demonstrated elsewhere in the treatment or organic chemical wastewater. Neutralization of wastewaters before the primary lagoon would be required